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CIVIL ENGINEERING.

Annual Report of the Board of Canal Commissioners, with Accompanying Documents, for the year ending November 30, 1847.

The Canal Commissioners of Pennsylvania in making their report of the operations on the canals and railroads of this commonwealth, for the fiscal year commencing December 1, 1846, and ending November 30, 1847, would remark that the receipts up to the first of October, were unprecedentedly great, and the expenses as low as in any preceding year; but on the 7th and 8th of that month a most disastrous flood swept over much of the main line and Susquehanna and West Branch divisions, interrupting the through navigation between Philadelphia and Pittsburg to the close of the year, and suspending that of the Susquehanna and West Branch divisions for a portion of the balance of the season. Notwithstanding the diminution in the revenue from this cause, the receipts and expenditures for the year present the following gratifying result:—

RECEIPTS.

From the Philadelphia and Columbia railroad,	$ 574,988·27
" Allegheny Portage railroad,	230,660·88
" Main line of the Canal,	425,396·78
Total gross receipts on the Main line,	1,231,045·93
From which deduct drawbacks,	7,500·95
Carried forward,	1,223,544·98

Brought forward,		$ 1,223,544·98
From the Delaware Division,		172,191·15
" Susquehanna, and North and West Branches, deducting drawbacks,		185,839·74
Total gross receipts on all the lines,		$ 1,581,575·87

EXPENDITURES.

On the Philadelphia and Columbia railroad,		$ 255,241·00
" Allegheny Portage railroad,		168,253·40
" Main line of canal—*Ordinary expenses*,	114,431·88	
Damages from floods,	50,035·61	
Clark's Ferry bridge,	14,832·93	
		179,300·42
" Delaware Division,		24,108·48
" Susquehanna, and North and West Branches—		
Ordinary expenses,	50,668·53	
Damages from floods,	10·904·00	
		61,572·53
Total expenditures,		688,475·83
Total gross receipts,		$ 1,581,575·87
Expenditures,		688,475 83
Excess of receipts over expenditures,		$ 893,100·04

If the pay of the Canal Commissioners, Secretary, clerk hire, messenger and incidental expenses of their office, amounting to $ 5055·64, be deducted from the above sum, it will leave $ 888,044·40, as the net revenue from the canals and railroads of the Commonwealth for the year ending November 30, 1847; being an increase of $ 307,522·27, over the net revenue of the previous year. Judging from the receipts up to the 1st of October, it is confidently believed that had there been no interruption from floods, the revenue from tolls would have reached $ 1,900,000. The expenditures, which amounted to $ 688,475·83, would, by deducting $ 60,939·61, the cost of the repairs of damage by floods, have been reduced to $ 627,536·22—leaving the net revenue at $ 1,272,463·78, instead of $ 888,044·40.

It will be seen from the foregoing statement that the expenditures for the year, have been swelled by the repairs of the damages caused by the floods. The augmentation of motive power to meet the increase of tonnage on the Philadelphia and Columbia, and Allegheny Portage railroads, has also increased that item of expenditure beyond the amount required for the preceding year.

In making up their statement of receipts and expenditures, the Board have been governed by the actual amount of tolls received, during the year, and the entire cost of motive power, repairs, expenses of collection, &c., whether paid or unpaid. This will account for any apparent discrepancy which may appear between this report, and those emanating from the accounting departments, which are made up from settlements to the close of the fiscal year.

The ordinary repairs of the several lines of canal and railroad have been executed with as much economy as was found consistent with an increasing business, and were confined within the estimate presented in the last annual report of the Board.

The accompanying statements exhibit a large increase in the tonnage transported, as well as the several articles embraced in that increase. They likewise exhibit a steadily increasing trade upon the works of the commonwealth, independent of any sudden and temporary demand for the productions of this or of neighboring states.

On the articles of coal, iron, flour, and grain, the tolls collected at the several offices during the year, were as follow: *

Coal, - - - - -	$ 218,970·27
Iron, - - - - -	96,582·08
Flour and grain, - - - -	133,596·27 †

A detailed statement of the operations on the several lines, is deemed unnecessary, a condensed view being all that is required, either for the information of the public or the action of the Legislature.

The accompanying report of the superintendent of the Philadelphia and Columbia railroad gives a detailed statement of the business of the road for the past year. The expenses exceed the estimates presented to the last Legislature. But this increase of expense bears no more than its just proportion to the increased business of the road. During the winter and spring months a much larger amount of tonnage was transported over it than for any corresponding period of previous years. The tonnage conveyed over the road in 1847 was two hundred and thirty-four thousand two hundred and twenty-nine tons, being an excess of ninety-four thousand six hundred and ninety-nine tons over 1846. This large increase of transportation necessarily increased the expenses of the motive power and repair departments. But notwithstanding this increased expenditure, the net revenue derived from the road is three hundred and twelve thousand four hundred and nine dollars and twenty cents, being an increase over the net revenue of 1846, of sixty-three thousand three hundred and seventy-nine dollars and eighty-seven cents. Nearly the full capacity of the present motive power was called into requisition during the early part of the season. Two new locomotive engines, contracted for in 1846, were placed upon the road in the spring. There are now thirty-seven locomotives in good running order. Two others are under repairs, which will be completed during the winter. The whole motive power of the road will thus be in order for the spring business. If there should be any considerable increase in transportation over the past year, it may become necessary to place at least two new engines on the road the present season.

* The names of the offices are omitted—the totals only are given. Com. Pub.

† No return for flour and grain from office at Johnstown. The maximum rates of toll render it impossible to ascertain with correctness, the amount of toll paid on these two articles shipped eastward at Johnstown and Columbia. It is estimated that at least fifty thousand dollars should be added to the above statement of toll received on flour and grain at those offices.

The trucks for the conveyance of section boats which were originally put on the road, have been found to be generally inadequate in strength to sustain the weight which they are required to transport. The consequence has been, that they have required frequent and heavy repairs, and are often out of order. The superintendent reports, that "of the fourteen sets with which the business of the spring was commenced, only three (those last built at Columbia) are in a condition for service next season. All those which came from the Portage railroad will require thorough repairing, and those bought from the Reliance line will require eight new trucks and three new cradles entire, besides other extensive repairs. One set has been entirely destroyed." Directions have been given to have the required repairs made to these trucks, so that they shall be ready for transportation before the opening of navigation.

The cost of repairs for the year has exceeded the estimate only two thousand and ninety-five dollars and forty-five cents. About sixty tons of new rails, eleven thousand cast iron chairs, twenty thousand feet of mud sills and string pieces, and ten thousand one hundred cross ties, have been put into the road during the season. Valley Creek and Coatesville viaducts have received extensive repairs. These structures are now in a safe and substantial condition. Repairs were likewise made to the other viaducts, and to the small bridges, water stations, &c. About one hundred tons of new rails will be required for the present year. The largest portion of this iron will be required on two short sections of the road—the first extending from Vine and Broad streets to the Schuylkill viaduct, which is now scarcely passable, owing to the large accession of tonnage from the Reading railroad, and to the number of sidings connecting it with quarries, warehouses, &c.: the second extending from the head of the inclined plane to White Hall, on which there is but a single track. In reference to this last mentioned section, the superintendent observes, that "the propriety of relaying the north track from White Hall to the inclined plane, has been so often pressed upon the attention of the Board and the Legislature, that it is deemed unnecessary to dwell upon the subject in this report. All the arguments hitherto used in its favor are still applicable. The expense, detention, and annoyances, caused by the necessity of stopping the trains at White Hall, have been felt in a greater degree the past year than formerly, on account of the increased amount of business; and it is earnestly desired that measures will be adopted to remedy the evil." The single track from White Hall to the head of the inclined plane is not sufficient to pass with facility the present amount of tonnage conveyed over the road. It is manifest that, upon the completion of the Pennsylvania railroad, from Harrisburg to Pittsburg, a large additional amount of trade will be thrown upon the Philadelphia and Columbia railroad. To meet that accession of business, it will be necessary to relay the north track between the points just indicated, or to avoid the inclined plane. As a measure of economy, leaving out of view the greatly increased facilities which it would give to transportation, the Board are convinced that the adoption of the last mentioned alternative is the true policy of the

Commonwealth. The arguments in favor of avoiding the plane have been so frequently presented to the Legislature, as to render their repetition unnecessary. The south track cannot pass the tonnage with the requisite facility. The north track must, therefore, be relaid, if the present line from White Hall to Philadelphia be preserved. By avoiding the plane, the expense of relaying this portion of the road, together with that annually incurred in keeping up and superintending the machinery of the plane, will be saved. The Board have, therefore, deemed it their duty again to call the attention of the Legislature to the subject, trusting that that body will give it that consideration which is demanded by its immediate connexion with the prosperity of the main line of State improvements.

The Allegheny Portage railroad was opened for transportation on the 11th of March, and was closed on the 26th of November. Much damage was done to the road by the flood of the 7th of October. Two stone viaducts of forty feet span each, over the Conemaugh, were greatly injured; the boat-slip at Hollidaysburg filled up; the track at the foot of the planes, Nos. 7 and 8, carried away, and the road at several other points materially damaged. Temporary viaducts were constructed, and the road repaired, causing a suspension of business for only one week. The estimated cost of the damage to the road by the flood is fourteen thousand dollars.

The motive power was found inadequate to the demands of an increased trade. Although two engines had been transferred from the Philadelphia and Columbia railroad; yet the worn out condition of several of those previously on the road, compelled the superintendent to resort to the assistance of horse power at a period when the price of provisions and labor was on the advance. This has necessarily added to his expenditures. The Board believe that it would be economy to place three new engines on the road, so as to supersede as far as practicable the use of horse power. The increase in the tonnage transported on the road over that of 1846, is fifty-five millions nine hundred and forty thousand and eight hundred pounds.

The nett receipts from tolls, from all sources, is sixty-two thousand four hundred and seven dollars and forty-eight cents. It is, however, proper to remark that this amount does not show the actual profits of the road. A large amount of tonnage, paying a maximum rate of toll, is shipped both from the eastern and western termination of the main line. This toll, which includes the railroad toll, is paid at the offices where the articles are first shipped, and is consequently not carried to the credit of the Allegheny Portage railroad. A comparison of the receipts and the expenditures does not, therefore, show the full amount of profit derived from this portion of the public works.

In the truck department, considerable difficulty was experienced during the first part of the season, from the limited number of sets of trucks for the conveyance of section boats. As a large number of these boats had been built, and were actively engaged in transportation, it was deemed a simple act of justice to those who had embarked in the trade on the implied pledge of the State to furnish them with the means of crossing the Portage, to give them the same facilities as

were enjoyed by those using a different mode of conveying goods. Five new sets were, therefore, procured and put on the road during the season. Two sets have been nearly completed at the depot at Johnstown. These will increase the number from seventeen to twenty-four; and as they will all be in good order for the spring business, they are deemed sufficient to meet the demands of section boats for the ensuing year, without producing any unnecessary delay.

The attention of the Legislature has been called, in previous reports of the Board, to the condition of the tracks upon the inclined planes. The superintendent, in his accompanying report, again urges the importance of relaying some of these tracks with heavy T rail. The proposed repair cannot be delayed beyond the period when the Pennsylvania railroad company shall form a connexion between their road and the Portage. The decay of the wooden superstructure, and the worn out flat rails will render it impossible to do the business consequent upon the increased tonnage which may reasonably be expected to be thrown upon the road after the completion of the connexion, with that despatch so necessary to maintain the credit of our important line of improvements. A communication has been received from the company, stating their intention to form the connexion, and suggesting the necessity of placing the planes in proper order.

The Board merely desire at present to call the attention of the Legislature to the subject, leaving it to that body to determine the propriety of the repair and the period of its commencement.

(To be Continued.)

Extract from Lectures on Geology, by Professor ANSTED. *Delivered at King's College, London. On the Application of Geology to Engineering and Architecture, and the Supply of Water to Towns and Cities.*

The Professor treated of the supply of water as an engineering subject, apart from the supply obtained from land-springs, or small artesian wells, considered hitherto on a comparatively small scale, and rather with relation to agricultural purposes than engineering. The subject of drainage and water supply was, perhaps, connected as much with architecture as engineering; but, when he had discussed its relations to the one, it would scarcely be necessary to touch upon the other.

With respect to the supply of water, the Professor thought he could not do better than give them a short outline of what had been done lately with regard to the large and most important town of Liverpool, which had been noted, for some time, as a place which was badly supplied with water, and had been more remarkable than any other town in England for the prevalence of fevers, the more than average illness of its inhabitants, and the short duration of life in the major part of it. The members of the corporation appeared very anxious to do all in their power to remedy that which was certainly one

source of those evils—namely, the deficiency in the supply of water. Accordingly, they resolved to obtain an Act of Parliament, empowering them to adopt some measure, which should give the town a larger quantity of that important element. The town was situated on the new red sandstone, and had hitherto been supplied from wells sunk into that stratum, which consisted of a red sand rock, sometimes very soft, sometimes rather hard, intersected with occasional bands of marl, very much faulted with large and continuous veins, often filled up with clay, and many of them completely impermeable. The new red sandstone rested upon coal measures, and certainly contained a great deal of water, which was absorbed from the immediate surface, or drained into it from the hills in pretty large quantities, of which the actual limits were ascertainable, since they knew how much fell from the clouds, and how much was evaporated; and they could calculate how much was lost by drainage into the rivers. The supply thus obtained was found to be very insufficient for the necessities of the town, and it was supposed that the quantity could not be materially increased from this source. This point, however, had to be decided upon by reference to the structure of the district, and by calculating whether they got all the available water of the district, or only a part, and it turned out that the latter was the fact. The mode in which this water was obtained was by wells, with horizontal galleries at their bottoms, to allow the admission of a large quantity of water, which was then pumped to the surface. The water obtained from the new red sandstone contained oxide of iron and some salts of lime and magnesia, which made it exceedingly hard, and ill adapted economically for many useful purposes connected with the manufactures of that neighborhood, and in all operations in which soap was required. It was very good to drink, but unfit for other domestic purposes. The question was, whether a sufficient supply, even of this water, could be obtained from the district? The proprietors of the wells attempted to show that an increased quantity could not be obtained. It was to their interest that that should be the case, and they very naturally believed that it was so—consequently, they opposed all measures, the object of which was to obtain water from any other source. The corporation gathered all the information that could be obtained locally, and then called upon several scientific men for their opinion; and it is a fact of great interest, as illustrating the present practical position of geology, that it was thought necessary to have the opinion of persons, more noted for their geological knowledge than for simply a practical acquaintance with engineering. Professor Phillips was first invited to give his attention to the subject, but was prevented from doing so by his engagements with the Government. He (Professor Ansted) was then applied to, and after close examination and full consideration, he came to the conclusion that a sufficient supply could not be obtained from the new red sandstone formation, he being of opinion that, though a somewhat larger quantity might be had of the water which fell on the district, yet that would not be nearly enough for the requirements present and prospective of a town like Liverpool. What was next to be done? Then came in that ad-

mixture of engineering with geological science, now necessary indeed to every engineer, who wished to do his work satisfactorily, and with the consciousness that, whatever the result, every means had been adopted which the circumstances of the case would allow. The engineers looked about the neighborhood far and near, their object being to discover where the necessary supply was to be found. One scheme, which met with considerable favor at first, was to take the water from the Bala Lake, in North Wales, and convey it to Liverpool, a distance of 60 miles, by closed canals. Great natural obstacles, however, intervened, and it was found that this plan involved an enormous expense, with the chance of incurring still greater outlay in overcoming several of those natural obstacles, which could not be well estimated until the work was attempted. This scheme, after exciting much discussion, was at length abandoned, and the engineers began to look nearer home. After again considering the supply from the wells, and again convincing themselves of its utter inefficiency, they found they must resort to other means, and thus originated the somewhat celebrated Rivington Pike scheme. The Rivington Pike district presented a hilly surface of 17 square miles, admirably adapted by nature for such a project. The plan pursued in this case was to take the district and measure its area of drainage, then to estimate the quantity of water that could be obtained from it, and, finally, to consider how the water might be best accumulated. This was a beautifully scientific problem, perfectly practical indeed; but one which had rarely, if ever before, been tried to the extent now proposed. First of all, they had to see whether the quantity of water would be sufficient; and this was effected by accurately marking the water shed, observing where all the rills and streams could be caught conveniently, and, when caught, considering whether they could be conducted into some sound and sufficient reservoir. The model on the table, which was an accurate representation of the district, would show that all those points were readily attainable. The drainage was regulated by the shape of the country, and it might be seen either by the Ordnance Map, a contour map, or a model. In this case, he was able to exhibit a model, which was the best, but the Ordnance Map was the guide originally used. Having then found the area, the question whether it would yield a sufficient quantity of water to supply the town of Liverpool was next to be decided. This calculation involved a considerable amount of knowledge of geological structure. It was easy to tell how many inches of rain descended from the sky on a certain space and in a given time; and they had only to multiply that by the whole area intended to be drained, and they would have the exact quantity which fell upon the whole. That was simple enough; but they had then to ascertain what was the nature of the surface on which the water alighted; for if it were permeable, as sand, for instance, it was obvious that a large proportion would be absorbed and lost; or, if there were many hollows, the water would lie in them and evaporate. These and other geological considerations, had all to be well considered; but geological science showed that the district, being composed of the bed of hard sandstone, called millstone grit, partially

covered over with shaley beds belonging to the coal measures, the whole of it might, for practical purposes, be regarded as impermeable. The sandstone rock, oftentimes very soft, was here very hard, a good deal faulted but not open—so that it would allow almost the whole of the water to run off the surface. The consequence was, that almost all the rain that fell ran into the streams, which a further examination showed might be readily collected into two principal reservoirs on the side of the district nearest to Liverpool, which would be 24 miles distant. The natural valleys, in which it was intended to place these reservoirs, had, no doubt, held water before, as the bottoms were covered with fresh water silt. There were also beds of alluvial clay—an additional indication that a considerable quantity of fresh water had at some period been there. By means of two or three embankments, these lower districts would thus accumulate that water, which the structure of the upper districts allowed to run off. The whole of the rain which falls upon an area of 47 square miles would thus be collected, producing a supply of 20,000,000 gallons per day, sufficient for the town of Liverpool were it twice the size, and also for the supply of a more useful and economical article to the mills, bleach-works, and other works in the neighborhood. Here advantage was taken of the peculiar natural circumstances of the district, to make the *minimum* quantity of surface produce the *maximum* amount of water; but which could never have been accomplished, but for a distinct geological knowledge of the structure of the district. Had it not been for a practical application of geological science, that on a certain description of stone the whole of the water would run off, the selection of the Rivington Pike district would never have been made, and the probability was, that Liverpool would have remained for a much longer period suffering from the want of a sufficiency of so vital a fluid. This was a remarkable instance, in which a knowledge of structure had been applied to superficial objects of this kind.

The Professor dismissed the subject of draining by explaining the nature of the operation of a newly-invented draining pipe (Watson's draining pipe), which was remarkably effective. It was cylindrical, with a great number of longitudinal slits, which were wider inside than outside, and thus counteracted any tendency to clog. These pipes were most useful to insert in beds of clay, and, even after a considerable length of dry weather, might be seen giving out water very plentifully. This efficient draining caused the beds to contract and crack, and, by thus making openings for the water, rendered the draining perfect. To the proper use of these pipes a knowledge of the dip of the beds was indispensable. Civ. Eng. & Arch. Jour.

Extract from the Report of the Superintendent of the Coast Survey, showing the Progress of the Work during the Year ending October, 1847.

Use of the electro-magnetic telegraph for differences of longitude.—The use of the telegraph lines established between Washington and

Jersey City, opposite New York, to obtain differences of longitude, has been continued during the present season, and the attempts to obtain differences of longitude, by this method, between Washington, Philadelphia, and Jersey City, have proved entirely successful. The arrangements explained in my report of last year were found sufficient for the continuation of the work. The superintendent of the national observatory, Lieutenant M. F. Maury, again directed the co-operation of that establishment. The observations at Philadelphia were under the direction of Professor Kendall, and those at New York under the direction of Professor Elias Loomis. The details of observation were arranged, and the connexion of the different parts secured, by assistant Sears C. Walker, of the Coast Survey, who was charged with the operation.

The principle of this method is well understood to consist in transmitting signals at a known or determined time, from one telegraph station to another, where they are noted by a time-keeper, well regulated to the time of the place. The difference in the times of giving and receiving the signals, according to the local time at each station, is their difference of longitude expressed in time.

The signals are given at one of the stations by pressing a key, which causes the closing of the circuit. This closing, it is intended, shall be simultaneous with the ticking of a clock or chronometer at the station. The circuit being closed, if the electrical wave or current takes a sensible time to propagate itself, or to pass from one station to another, the absolute time of the signals reaching the second or receiving station is sensibly different from that of making the signal at the first or giving station. A coil about the poles of a horse-shoe magnet of soft iron, forms part of the circuit through which the electrical effect is transmitted. Under its influence the soft iron becomes magnetic, attracting the soft iron bar (armature or keeper) delicately poised at a determined distance from the poles of the magnet; the movement of this keeper sets in action a local battery which gives sufficient power to make the dots and lines constituting the Morse telegraphic signals. The click of the keeper of this temporary magnet is compared, at the receiving station, with that of a clock or chronometer, thus marking the time at which the signal, made at a known time at the giving station, is received. From this explanation, it appears that there is liability to error: 1, in the clock times at the different stations. These are easily examined and the most probable times assigned at each station, the personal equation for clock correction being determined and allowed for, they may then be treated as if only very small errors existed. 2. The time of striking the trigger or key, to close the circuit, may not coincide with the clock beat. The error, if any, from this source is determinable by experiment; and careful experiment failed to detect a sensible amount. 3. The electrical effect may take a sensible time to be transmitted, and this may be known, if other sources of error could be got rid of, by transmitting signals from an eastern to a western station, and vice versa; and it may be rendered null in its effect upon determinations of differences of longitude by such alternate transmission, or it may be examined in its combined

effect with the next error. 4. That of the sensible interval, if any exist, between the activity of the coil, its action in inducing magnetism in the receiving magnet, and the click of the keeper of this magnet. 5. The error in noting the fraction of a second as denoted by the clock. It was perceived that this difference in the estimate of fractions of a second, rendered the transmission of signals, by the beats of a well regulated sidereal clock, and their reception by another sidereal clock, of little avail, the time falling constantly upon the same fraction of the second. The transmission of signals, by beats of a mean solar chronometer, and the marking of the time of reception by a sidereal clock or chronometer, carries the fraction of the second over every part of the whole second, and once, at least, in ten minutes marks the coincidence of the beats of the two time-keepers. By observations of the coincidences, and the marking of intervals at the same station, the law by which each observer varied in the estimate of fractions of a second became known, and, of course, the differences (or receiving personal equations) of each observer, supposing them to be constant. Pains were taken to compare personal equations by all the observers. It turned out, finally, that this might have been done by transmitting signals; but, then, to have assumed it would have been to anticipate a result which was sought. The part of the error, then, of receiving signals from error of noting time, was ascertained numerically, and its value could be assigned within certain limits in any case. The inference is drawn from an examination of this class of personal equations, "that when the two clocks" (the one by which signals are given, and the other by which they are received, both being rated either to mean solar or to sidereal time) "do not coincide in their beats; the observers, on the average, set down the fraction of a second of the signal received too small." Of the five errors, then, which I have enumerated, the numerical values could be assigned to two, (viz: 1 and 5,) and one (viz: 2) was insensible. After assigning the values in any particular case to 1 and 5, there remain residual errors, caused by 3 and 4. Now, it is plain that both of these will affect the result alike; that is, will tend to make the time of receiving the signal later than it should be by the amount of retardation of the wave or current, and by the difference in the time of its reaching the spiral coil and the click of the keeper of the receiving magnet. But a comparison of the observations shows a very small residual quantity having just the opposite sign, the signal being apparently received *earlier* than it was given. From this, the nullity of both these corrections, 3 and 4, is fairly inferred, and the interesting consequences follow, that "the telegraphic method of comparing clocks, distant two hundred miles from each other, is free from error when the method of coincidence of beats is employed, and that the probable error of the longitude, from this method, is the same as the mean result of the computed relative correction of the clocks for the nights of observation." An investigation of the probable value of such error shows that, under favorable astronomical circumstances, and with due care in the use of the transit instrument, "the astronomical difference of longitude, between any two stations of a trigono-

metrical survey, may be determined by telegraphic signals, with a degree of precision of the same order as that of the differences of latitude," the inaccuracy depending upon the same causes as the deviation of the plumb-line.

The very interesting and elaborate report of Assistant Walker, of which I have thus given the chief conclusions, will be published with the other results of the year. It contains, in separate sections—1, a discussion of the theory of Morse's telegraph; 2, of the difficulties in the use of the telegraph, from imperfect insulation; 3, the theory of the adjustment of the magnets; 4, the theoretical discussion of the errors of the clocks at the different stations is thoroughly made, and equations of condition are formed for deducing the most probable errors from the observations; 5, equations of condition are formed for giving the most probable difference of longitude from the observations. Under this head, the mode of giving and receiving signals is discussed; the essential character of the method of coincidences is insisted on; tables of personal equations for each observer, and each fraction of the second, are framed. The key-beat and armature-beat in giving signals, are found not to differ. The correction for time of transmission of electrical effect, or "circuit time," and for the armature-beats of the receiving magnet, are explained, and the whole of the physical circumstances are expressed in an algebraic form. 6. The corrections for errors of the clocks at the several stations are deduced and applied. Full tables of the observations at the several stations are given in this connexion. The corrections for the differences in noting time by the different observers, (or personal equations of clock corrections,) are next made. 7. The table of signals transmitted and received is given. 8. The results of this table are examined and compensated by the equations of condition. 9. Numerical values are assigned, from observation, to the quantities independently compared, and the consequences obtained which have been given above.

Measurement of base line.—The site for the base line on Dauphin island was selected by Asssistant F. H. Gerdes, after his general reconnaissance of this part of the coast in 1845; and two preliminary measurements with the chain were made at different times, under his direction, by Messrs. Walker and Greenwell. The site presents great facilities for measurement and connecting the base with the triangulation. It is exposed, as all sites near the ocean must be, to the gradual or sudden action of the water, but, as far as can now be foreseen, is likely to be permanent, so as, if necessary, to afford an opportunity for remeasurement. The base was laid out from near the woods on Dauphin island westward for nearly seven miles to the western extremity of the island, which at that end is increasing. It has been kept as far as practicable from the gulf side of the island. It passes, first, through the firm salt marsh which borders the Mississippi sound, then over the dividing ridge of low sand hills, upon sand flats with scarcely a rise, again upon firm marsh or sand flats covered with short grass on the sound side of the island. All the preparatory arrangements were made under the direction of Mr. Gerdes before my arrival at Dauphin island.

The measurement of the base was made by me, assisted personally by Mr. Gerdes and his party, to which were attached Assistant Julius E. Hilgard and Mr. J. Hewston. The grading, where required, was done under the direction of Mr. W. E. Greenwell. The records were kept by Mr. Samuel Arthur. The apparatus was safely transported from Washington to Dauphin island, under the charge of Mr. Thomas McDonnell, who also aided in the measurement. Mr. Wurdeman accompanied me to make the repairs which it was supposed might be required from time to time, to examine the apparatus, and to see the working of the different parts.

The base apparatus presented some novel features in construction, the adaptation of others not hitherto used in field work, and a choice of parts previously used by others. The general plan was devised by me, and the details by Mr. William Wurdeman, by whom they were executed under my direction.

This is not the place to describe the base apparatus, but I may be allowed briefly to allude to its general features:

1. The measuring bars were upon the compensating system, first used, I believe, by Colonel Colby in Great Britain, and by Mr. Borden in the United States, but the mode of obtaining the compensation differed entirely from that used by either of these gentlemen.

2. A principle was introduced in reference to the dimensions of the bars, which, if at all recognised, has not been hitherto applied, though obvious enough. A bar of brass and a bar of iron of the same dimensions, exposed to the same source of heat, will not heat equally in equal times. This is well known to depend upon the different conducting powers of the two metals, their different specific heats, and the different powers of their surfaces to absorb heat. The bars, then, if of equal sections, when the temperature is rising or falling, have not the same temperature, and the system is not compensating. The surfaces are easily made to absorb equally by the same coating, and the *sections must be so proportioned to each other that the bars will have the same temperature* when exposed to variable temperatures of the atmosphere and of the case containing them. Having arranged the sections approximately, using numbers taken from the books, the changes in length during increase or decrease of temperature were not perceived when microscopes were used supported upon wooden stands, or even upon stone blocks of small size; the means of measurement were not sufficiently delicate to perceive them, or they were masked by greater changes in the supports. When the level of contact was substituted for the microscopes, or when Mr. Saxton's reflecting pyrometer was employed, these changes became very perceptible, and it was necessary to resort to direct experiment upon the materials of the bars themselves to obtain even approximate compensation, and then to correct a small residual quantity by applying a covering more absorbent of heat to one bar than to the other. If such changes have not been perceived hitherto, it has been because adequate means were not used to detect them. I am indebted to Lieutenant A. A. Humphreys, and to Mr. Joseph Saxton, for the perseverance and skill

with which the experiments necessary to a complete adjustment of the apparatus were made.

3. The lever of contact and level first used, I believe, in the adjustment of standard measures by Bessel, was applied to indicate the lengths of the bars. The levels were so delicate, that several divisions upon them made up a quantity entirely insignificant in the measurement. The doubt which I had was, whether the sensibility of the apparatus had not been carried too far. This was, however, entirely removed upon finding the rapidity and certainty with which it could be used. The contact of two adjacent measures was between a blunt knife edge and a plane of agate.

4. The trussed support for the bars adapted to bearing the apparatus at two points only, and the tin covering or tube which surrounded the whole, were similar in principle to those used by Mr. Borden, but differed entirely in the adaptation of them; the bars moved freely on the trussed frame upon rollers, and were not attached to the covering tube in which the trussed frame itself was merely supported. The tin covering was conical and was doubled.

5. The trestles admitted of the various motions required in placing the apparatus. The length of the whole, about twenty feet, (six metres,) gave a weight which permitted easy and rapid transfer by four men, when covered with several thicknesses of imperfectly conducting material to keep the fluctuations of temperature within moderate limits. In arranging so many and various details, it is not to be expected that some of them will not admit of improvement; but the performance of the apparatus was highly satisfactory, working with a rapidity and accuracy quite going beyond my most sanguine expectations, and making comparatively light the labor of all concerned by the excitement produced by expectations constantly surpassed. The contacts were usually made in much less time than the setting of the forward trestles for the next measure. The following statistics of the measurement will suffice for the present to show that we have obtained a useful auxiliary in a geodetic survey, especially when the difficulties of triangulation render advisable the measurement of frequent bases.

The greatest length measured in the course of a day, in the final measurement, was 183 tubes, equal to nearly seven-tenths of a mile; the least, 47 tubes, or one-fourth of a mile; the average, 104 tubes, or four-tenths of a mile. The whole measurement of nearly seven miles was completed in seventeen working days, not reckoning the time lost by bad weather, or occupied by change of camp, and by comparisons of the apparatus. The length of the apparatus was compared before and after the final measurement with a standard iron bar, with which it had been compared in the office, by using Mr. Saxton's reflecting pyrometer.

The accuracy with which a remeasurement of considerable length could be made, was tested more than once in the measurement, but it was determined to make a more complete direct trial by establishing intermediate marks, and noting by the micro-telescopes attached to the ends of the bars the deviation at intervals. The greatest devi-

ation in the length of seventeen tubes was between one and two hundredths of an inch; the average in twelve cases of repetition, not regarding signs, was five thousandths of an inch, the final error at the end of the third of a mile remeasured was nothing. The probable error of remeasuring 112 yards was five thousandths of an inch, making in the whole length of the base, and supposing all the errors to fall in the same direction, which is physically most improbable, about five-tenths of an inch. The great practical difficulty found at the outset, was to obtain a mark which would stand unmoved in the sand, to which to refer the apparatus on recommencing a measurement; this was satisfactorily obviated after many experiments, and the marks, which I have just stated to have been placed at intervals, may be assumed generally to have been stationary from one measurement to another. Incidentally, this remeasurement gave a strong test of the perfect compensation of the apparatus, under sudden changes of temperature as well as for different stationary temperatures. A storm came up after the second measurement was commenced, which interrupted it for between one and two hours, and cooled the air suddenly about four degrees. The second measurement was made at a lower temperature by some five degrees than the first, and under exposure to a sudden fall of temperature.

At the nearest whole measure to each mile, stone posts were planted in the sand and duly secured, and at the ends of the base, monuments were erected and secured with great care to mark the extremities of the line. Smaller stones were also placed in the prolongations of the base and across it at the ends, giving lines intersecting upon the extremities of the base line. Full descriptions of these monuments and stones, and of their condition at the close of the work, have been recorded in the office of the survey. They have been visited once since the measurement by assistant Gerdes, and their condition reported. The whole time occupied by my party at the base, including the landing and reshipping of the apparatus, the pitching and striking the camp, and its removal from the east end towards the west end, the measurement, placing monuments, trials of apparatus, &c., was six weeks, namely, from the 30th of April to the 12th of June. The final measurement (occupying 27 days) was commenced on the 12th of May and ended with the 8th of June, including in this period three days, when the camp was removed, and four Sundays. We were much indebted to Major Ogden, of the corps of engineers, for the important facilities which he afforded us.

Laignel's Safety Brake.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

M. Laignel has proposed a safety brake for railroad cars, (patented in 1841,) consisting of a sliding piece, the lower part of which fits accurately upon the top of the rails; this is attached by means of four levers, to a vertical axis passing through the bottom of the car, equidistant from the four wheels, so that by turning a handle, the brake may be raised or depressed vertically. When not in action it is raised

a little above the rail, but by a simple revolution of the handle it may be pressed against the rail, and be made to check the velocity of the car by its friction; when required, the pressure may be carried so far as to lift the wheel off the rails, and leave the car resting upon the brake-pieces (which are of considerable length), and thus the whole weight of the car is rendered effective by its friction in arresting its progress.—*Bull. de la Soc. Indust. Nat., August*, 1847, *p.* 401.

Artesian Well at Venice.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

In an artesian well sunk at Venice, for the purpose of supplying the city with fresh water, four beds of turf were traversed, at the respective depths of 97, 157·5, 279, and 412 feet. They show that at four different epochs, the soil, which was gradually sinking, was covered to a slight depth by fresh water. Water was met with at the depths of 16, 131, 174, and 197 feet. This latter water, which rises about 10 feet above the level of the lagunes, appears to have its origin in the marshy plains, which surround them; an origin which appears to be confirmed by the carburetted and sulphuretted hydrogen gases which escape from the water, and the large quantity of azotized matter which it contains, not sufficient, however, to render it unhealthy, or unfit for use.—*Ibid. September*, 1847, *p.* 558.

Speed of Ocean Steamboats.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Baron Seguier states that he saw, when at Havre, two English steam packets, the Success and the Express, which make the trip from Havre to Boulogne, which is 240 kilometres, (149 statute miles,) in 5 hours. These boats are very long, shaped like piroques, and carry their sails arranged in a new way, so that they can take advantage of the slightest wind, without losing the necessary stability of the vessel. Their engines are 350 horse power, built by Maudsley, on the annular system, which presents several advantages over the oscillating cylinders. —*Ibid. September* 1847, *p.* 570.

BIBLIOGRAPHICAL NOTICE.

Principles of Physics and Meteorology, by J. MÜLLER, *Professor of Physics at the University of Freiberg. First American edition, Revised and Illustrated with* 538 *Engravings on Wood, and two Colored Plates.*

This is the first of a series of works got up by Bailliére of London, in a beautiful style, and profusely illustrated with excellent wood-cuts; the book before us is a reprint by the American publishers.

The style of the getting up of the book is very creditable, but we

are glad to see that the works which are to follow, are intrinsically of a much better character. What the original may be we cannot say, but Prof. Müller's name is sufficiently well known to protect him from the suspicion of having written some, at least, of the blunders which are so rife, especially in the mechanical part of the book, and we suppose they may be fairly attributed to the ignorance of the translator, who manifestly had no knowledge whatever of the subject. The American editor has suffered his name to remain unknown—and he has done wisely—for had he attempted to rectify the work, he must have made it his own; whereas he has added a paragraph or two on well chosen subjects, such as the steam engine and Morse's electric telegraph, has translated the French weights and measures into English, which the original translator probably could not do, and has not corrected even the manifest typographical errors of the English book. In justification of our remarks, we ask the reader who has access to the work, to turn over its pages and read a paragraph here and there, especially in the mechanical part, and we feel sure that he will agree with us, that it is precisely such a book as, tempting the unlearned mechanic, by easy reading and handsome pictures, gives him false ideas of what it pretends to teach, so that his latter state is worse than the first. We give a few illustrations taken at random in justification of our remarks:

"All bodies are in one of these three conditions: either solid, *fluid*, or gaseous." (p. 31.)

"If we remove a piece of stone from the ground and *throw it from our hand, it will, when left to itself,* fall until it reaches the earth, &c." (p. 34.)

"Any certainty other systems (of measures) now possess, has been derived from a comparison with the system established in France." (p. 36, note.)

"*The mass of a body is always proportional to its weight.*" (p. 37.)

"In order to determine the specific gravity of solid substances, we must form from them a body of regular shape, as a cube or sphere, in order to estimate the more readily its cubic contents." (p. 40.)

These are enough from ten pages of the elementary part of the work,—but the rest of the treatise on the mechanical powers is about equally good, and the attempt to define and classify pullies is particularly amusing.

On page 73 we have glass twice mentioned as deficient in elasticity, once ranked with lead, and again contrasted with steel, which is perhaps, of all others, the solid which it most resembles in its physical properties. On the same page we have the following: "*absolute strength* is the force by which a body resists being torn asunder, when it is stretched lengthwise. This resistance evidently depends upon the *diagonal* section of the body to be severed, and is proportional to it." Here the translator has evidently confused the author's meaning, giving *diagonal* for *transverse*; as it doubtless precedes it in his dictionary.

On page 111 is a perfectly original attempt to account for the ag-

gregation of mercury and water in spherical drops. The ordinary theory of attraction of cohesion is rejected, because it only acts at insensible distances, and the drop has a sensible size, and then follows an explanation which we commend to the reader, for it is too long to extract. But the termination is too good to be omitted. "A liquid *strives* therefore to terminate in a plane surface, but a mass, free on all sides, cannot be surrounded by one single plane."

On page 117 the translator recommends an experiment upon the weight of air, by hanging a *balloon*, furnished with a stop cock, to one arm of a balance. We say the *translator*, for the French use *ballon de verre* to signify a glass globe, which is what the author meant and doubtless said.

Again, if any of our readers have an extra stock of patience, and no trials to wear it out on, let them try the demonstration of the law of variation of atmospheric pressure given upon page 131, where a method originally bungling enough, has been so nicely complicated by what we take to be two typographical errors in the mathematical signs as to be very nearly incomprehensible. We must do the American edition the credit to say, that it is a literal copy of the English, errors and all.

But enough of this; it is very evident that the author knew but little of mechanical philosophy, and that his translator knew not even the meanings of the terms. What the American reviser knows upon the subject does not appear. The rest of the book is much better. The article on sound is generally good, and the wood cuts, especially those of the organs of hearing, are admirably well done, and are very instructive. The article on light, we have not had time to read, but the illustrations are beautiful.

That on magnetism is good, though not a little disfigured by the ignorance of the translator. The same thing occurs in that upon electricity, where, for instance, the two fluids in presence of each other, as in the case of the charged Leyden jar, are spoken of as combined. There is also an American error of the press in the wood cuts 371 and 372, and numerous typographical errors have slipped uncorrected from the English into the American edition. Indeed, it is curious too, that a work should be produced at this time in England, in such an attractive style, and so totally negligent of English contributions to science. The constant battery, invented by Daniell, is ascribed to Becquerel, who, we are aware, claimed it, but failed entirely to substantiate the claim. The contact theory of Germany is given, in total exclusion of the more comprehensible chemical theory now almost universally adopted in England and France, especially since the experiments of Faraday, which are alluded to by the author, but merely alluded to. Surely if the English translator had been familiar with what had been doing for the last ten years in his own country, this scandal would not have been permitted.

In fine, the article upon heat will probably be found to be the best in the volume, since, so far as we have had the patience to compare them, it is nothing but a copy of Pouillet's article upon that subject, in his Traitè de Physique, where even the figures are to be found. We

conclude, then, as we began, that we are glad to know, that the works of this same series to come hereafter, are of a much higher order of merit, and that their scientific value will be more worthy of the trouble and expense bestowed upon them. F.

AMERICAN PATENTS.

List of American Patents which issued in the month of January, 1847, *with Exemplifications, by* CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

1. For an *Improvement in Clocks and Time Pieces;* Chauncey Boardman and Joseph A. Wells, Bristol, Hartford county, Connecticut, January 1.

The patentees say,—"The nature of our invention consists in placing the driving spring upon the same shaft with the fuzee, connecting the shaft of the combined fuzee and spring to the frame of the clock movements, and attaching one end of this spring to the frame of the clock movements."

Claim.—"What we claim as our invention, and desire to secure by letters patent, is the placing the driving spring and fuzee on the same shaft, connecting the same to the movement frame of the clock, and the combination of the same with the barrel and movements of the clock, substantially in the manner and for the purposes set forth."

2. For *Improvements in the Apparatus or Truss for the cure or relief of Prolapsus Uteri;* Frances Carter, Washington, Rappahannock county, Virginia, January 1.

The patentee says,—"The nature of my invention consists in combining two uterine supporting pads with an abdominal and a dorsal pad, or with either of them, in such manner that they (the uterine supporting pads) shall act upon the pelvis on each side of the labia, for the purpose of giving equal or better support to the uterus than can be given by the single perineal pads generally made use of; and of obviating the objections thereto, such as inconvenience in the use, injury from moisture, &c."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the making use of two uterine supporting pads, arranged in such a manner as to act on the pelvis on each side of the labia, and also their combination with an abdominal and a dorsal pad, or with either of them, substantially as herein set forth."

3. For an *Improvement in the Machine for Cutting and Harvesting Grain;* Clinton Foster, Laporte county, Indiana, January 1.

Claim.—"What I claim as my invention, and desire to secure by

letters patent, is the combination of the cutting and threshing apparatus described, in one harvesting machine; connecting the knives separately with the respective rods and the eccentrics, and their arrangement and combination with the guides and cutting plate, being a spur and balance wheel combined."

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4. For an *Improvement in the Machine for Excavating, Grading, and Solidifying roads;* Nathan Parkins, Frederick county, Virginia, January 1.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combining the scraper with a wheeled carriage or cart, in such a manner that it may be thrown into and out of action, and be regulated by an attendant upon the cart, by means of the elevating and depressing levers and the scraper handles, the whole being combined and operating substantially in the manner and for the purpose herein set forth."

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5. For an *Improvement in Carriage Wheels;* Ira Holmes, Moscow, Lexington county, New York, January 1.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the herein described method of inserting metallic spokes in carriage wheels, in combination with the making of the hub in two parts, one fitting within the other, substantially as described, whereby the spokes are firmly held in place and prevented from working loose by the jarring of the wheel, and also any one of them can be taken out for repairs and reinserted, by making the hub in two parts as described."

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6. For *Improvements in the mode of attaching Traces or Tugs to the Whiffle Trees of Vehicles;* Winant de Garmo (assignee of W. S. Ellison) Northumberland, Saratoga county, New York, January 5.

Claim.—"What I claim as my invention, and desire to secure by letters patent is the mode of attaching traces, &c., to the whiffle trees of vehicles, as herein described, viz: by rounding off the end of the whiffle tree and passing the end of the trace through a loop attached to the same; which end may be secured to the back of the whiffle tree either in the mode herein described, or in any other suitable manner.

"I also claim the peculiar mode of securing the end of the trace or strap to the whiffle tree, by the use of the button-headed stud and slats, as set forth and described."

7. For an *Improvement in Mills for grinding Grain and other substances, and drying or curing Flour or Meal*; Jean Baptiste Gendebien and Auguste Houyet (assignors to F. B. Hyde, of New York), Brussels, Kingdom of Belgium, January 5, 1847—antedated, U. S., February 11, 1846.

This is for the purpose of drying flour to prevent the necessity of kiln drying, and at the same time avoiding the burning of the flour by the clogging of the furrows, by forcing currents of heated air into the eye of the runner, and causing it to pass out radially between the staves.

Claim—"We wish it to be understood that we do not confine ourselves to the particular arrangement laid down in the drawing, nor to the position or form of the invention as there represented. But we claim as our invention, the causing of a current of air to pass between the mill stones from the eye, towards and out at the periphery, substantially for, and in the manner described, the said current being produced by a blower or any other convenient mode, either by drawing the same from the mill, or forcing it through, as fully described above.

"And we also claim drying or curing the flour or meal while under the action of the mill stones, by the introduction of a blast of heated air, substantially as described."

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8. For an *Improvement in the apparatus for Arresting and Consuming Sparks, and creating Artificial Draft;* James Montgomery, Memphis, Tennessee, January 7.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the mode herein described of creating draft, in chimney stacks, by means of the screw fan attached to the plate placed at the top of the stack, substantially in the manner described. And I also claim the above in combination with the perforated casing and shield, and in combination therewith, the tube, or trunk, and valve placed within it; all in the manner and for the purpose described."

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9. For an *Improvement in Toasting Coffee, called "Self-Toasting Aroma-Condensing Apparatus;"* John R. Remington, Baltimore, Maryland, January 7.

The patentee says,—"The nature of my invention consists of a metallic wheel of buckets, somewhat similar to an overshot water wheel, but of small diameter, the buckets of which receive the grains of coffee that drop one by one from a hopper above, and which, by their weight, turn the wheel that carries the grains slowly through a circular trough below, that extends around about one third the circumference of the wheel, and which is sufficiently heated by a small furnace to toast the coffee during the time that it is carried from one end to the other, when it is discharged by means of an inclined spout into a vessel below, where the aroma is condensed by cold water in a pan above; the buckets of the wheel being so formed as to contain the

requisite quantity of coffee, to insure the turning of the wheel by the weight thereof, and so curved near the periphery as to drag the grains through the trough and up to the spout, and the hopper being provided with a hinged shute, the inclination of which can be increased or decreased to regulate the delivery of the grains of coffee into the wheel, whereby the motion of the wheel is gauged to the temperature of the furnace."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the method, substantially as herein described, of toasting coffee by means of a wheel of buckets, which receives the grains of coffee from a hopper—when this is combined with a heated trough through which the grains are passed by the rotation of the wheel, as herein described. And I also claim, in combination with the wheel and trough, the condensing vessel for the purpose of condensing the aroma of the coffee, substantially as herein described."

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10. For a *new and improved method of applying what are called by Tailors, the "Scye and Shoulder Measure for Cutting Garments;"* Miles G. Simril, Chester, South Carolina, January 7.

The patentee says,—"My invention consists, in part, in providing a spring-steel ring which I call the 'circular measure,' and which being set to the exact size of the scye-joint of a person, and properly located on the cloth from which the garment is to be cut, will represent, *on the cloth*, the scye-joint of the person, and act as a guide to the application of the 'shoulder measure.'"

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the spring-steel ring herein described, and called the 'circular measure,' and the 'shoulder regulator' thereto attached, which are manufactured and used in the manner herein set forth."

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11. For an *Improvement in the machine for making Tin Ware, called the "Tin Raising Machine;"* Alonzo Heaton, Irving, Chatauque county, New York, January 13.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination of the concave with the cone for raising or making a concave plate of tin or other metal, as described."

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12. For an *Improvement in the Knife for Cutting Timber, called the "Reversible Scolloped-edge Knife;"* Issac Crossett, East Burlington, Burlington county, Vermont, January 13.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the particular manner of combining and arranging the peculiarly constructed cutters, with the scolloped-backed stock, as set forth"

13. For an *Improvement in the Water Closet;* James Ingram and James Stuart, City of New York, January 15.

Claim.—"What we claim as our invention, and desire to secure by letters patent, is surrounding the basin with a dip flanch, when this is combined with the pan for containing water, substantially as described, whereby the escape of noxious odors is prevented when the basin is removed, and the necessity of uniting the basin with the top of the trunk avoided, as described. And we also claim the second jointed pan, for preventing the escape of odors when the first pan is opened, when this is combined with the first pan, substantially as described."

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14. For an *Improvement in the Fountain Pen, Shaft, and Pen Holder;* Walter Hunt, City of New York, January 13.

Claim.—"What I claim as my invention, and desire to secure by letters patent, in the above described fountain pen, is the filling tube of a graduated capacity for filling the pen, combined with the fountain pen, as above set forth and specified, or arranged in any manner which is substantially the same."

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15. For an *Improvement in Ploughs ;* Lorenzo Prouty, (executor of David Prouty) of Dorchester, Norfolk county, Massachusetts, January 13.

Claim.—"What is claimed as the invention of said David Prouty, and is sought to be secured by letters patent, is the adjustable and shifting wing, or wings, in combination with the mouldboard, as described, by means of which the same plough can be adjusted to the cutting of furrows of different widths, as set forth."

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16. For *Improvements in the machine for Splitting or Cutting out Plank, &c.;* I. R. Remington, Lowndes county, Alabama, and Robert Beale, Washington, District of Columbia, January 15.

The patentees say,—"The nature of our invention consists in the application of a double series of cutters, placed in line with each other; the first cutters of the series are made blunt on the edge and serve only to mark a short distance into the surface of the plank to be cut; the second pair are thinner, and are placed closer together, and they of course go deeper, and so on through the series, each successive pair being made thinner, and marking or cutting deeper, till the last pair meet in the centre, or nearly so."

Claim.—"Having thus fully described our improvements, what we claim as our invention, and desire to secure by letters patent, is, the employment of a series of cutters, the first of which has a blunt edge for indenting the surface instead of cutting it, the successive cutters being made progressively thinner, and cutting deeper, to the centre, all substantially as described."

17. For an *Improved Fountain for Shower Baths;* Henry Blodgett, Albany, New York, January 15.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the mode in which I have constructed and arranged the filling passage and the rose, as set forth and described, both being at or near the top of the fountain when erect, (it being understood that I do not intend to confine my claim to the case where the partitions inclosing the empty cavities are introduced, those latter not being absolutely necessary to, although greatly improving the action of, the apparatus). And in combination with the above, I claim placing the gudgeons upon which the fountain turns, *above* the centre of the cylindrical water receptacle; and adding a counter weight to the bottom of the latter, so as to cause the apparatus to right itself after inversion. I also claim the peculiar manner in which I have arranged the escape passages so as the more readily to cut off the water when the fountain commences to rise from its inverted position, and thereby prevent its spouting to the front. And I further claim the mode of producing the *drench*, by means of the cover applied over the rose—the whole being constructed and operating substantially in the manner and for the purpose set forth and described."

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18. For an *Improvement in the Machine for laying Cables, Ropes, Twine, and Cordage of all kinds;* William Joslin, Waterford, Saratoga county, New York, January 19.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, 1st, the combination of the revolving condensing tube with the stationary laying block, the former being constructed and operated in the manner and for the purpose set forth.

"2nd, the combination of the adjustable frustrum of a cone with the revolving shaft and condensing tube, for graduating the tension of the strands during the operation of laying them, as described."

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19. For *Improvements in the machine for Cutting or Forming Irregular Forms on Wood or other Substances;* Timothy Clark, New Haven, Connecticut, January 19.

The patentee says,—"The nature of my invention consists in placing the axis of rotation of the cutter wheel, or wheels, at right angles to the axis of rotation of the pattern and substance to be wrought into the desired form, when this is combined with an arrangement of machinery by which the pattern and article to be shaped are made to rotate during the operation of the cutter wheel."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the arrangement of the cutter wheel or saws, so as to cut in the direction of the grain of the wood, or other substance to be formed, when this is combined with the rotation of the pattern, and substance to be formed, during the operation of the cutters, substantially as described."

20. For an *Improvement in Horse Rakes;* Lewis Swift, Clarkson, Monroe county, New York, January 19.

Claim.—"What I claim, and desire to secure by letters patent, is the curve in the handles, in combination with the blocks affixed to the teeth, in the manner and for the purpose set forth."

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21. For an *Improvement in Hammers;* Charles Hammond, Philadelphia, Pennsylvania, January 19.

Claim.—"Having fully described the nature of my improvement in the manner of manufacturing claw, or other strapped hammers, what I claim therein as new, and desire to secure by letters patent, is the manner herein set forth of forming, and of confining the straps in place; the straps consisting of strips of iron of any equal thickness from end to end, and being beveled or dovetailed at their edges, to fit corresponding bevels in the eye, in the particular manner set forth."

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22. For an *Improvement in the manner of constructing Lamps for burning Volatile Ingredients;* Isaiah Jennings, City of New York, January 19.

The patentee says,—"The general construction of my improved lamp, is the same with that for which I obtained letters patent, in which the volatile mixture was made to ascend in a wick of cotton or other fibrous material, contained within a tube, in the upper part of which it is converted into vapor, and is allowed to issue from small orifices, where it is ignited and burns in the manner of gas lights. My improvement in this lamp consists in so constructing it, as that by turning the burner around to a small distance, the number of jets may be diminished, or increased, at pleasure, or the whole may be extinguished."

Claim.—"What I claim therein as new, and desire to secure by letters patent, is the so arranging of the tubes, and of the apertures through them, as that the outer tube shall, by turning on the inner, be made to vary the number of jets, or to extinguish the whole at pleasure, substantially in the manner herein fully made known; and this I claim whether the proportions for the jets be made to coincide precisely in the manner set forth, or in any other that is substantially the same, producing the same effect by equivalent means.

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23. For an *Improvement in the machine for Mortising Window Blinds;* Joseph W. Ingle, Upperville, Fauquier county, Virginia, January 21.

The patentee says,—"The nature of my invention and improvement consists in securing two stiles of a window blind, to the sides of a notched gauge bar, by means of arms extending from the sides of said bar, and a key which enters said mortises in the stiles—the teeth on the side of the gauge bar being made as far apart as the re-

quired distance apart of the slats of the blinds, said teeth being brought in contact with the spring dog, attached to the frame for holding the gauge bar, and stiles, in the required position, during the operation of mortising; the stiles being then moved by the operator between two cutters having a simultaneous action, by means of a vibrating lever, moved by the operator, to which the cutters are attached by slides, straps, or pins, or other more suitable contrivances, by which arrangement and mode of operation, two mortises are cut, one in each stile, at each movement of the lever. The operator holding the stiles in his left hand, and the lever in his right hand, and moving the stiles forward towards the cutters, one notch for every movement of the lever."

Claim.—"What I do claim as my invention, and desire to secure by letters patent, is the before described mode of mortising the stiles of window blinds, by securing two stiles to a notched gauge bar, and bringing the teeth of said gauge bar in contact with a spring dog, fixed to the frame between the two oblique cutters, attached by slides to a lever, which cutters are made to cut two mortises simultaneously, at each movement of the lever, one on each stile, and on opposite sides."

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24. For an *Improvement in the machine for Sifting and Cleaning Plantations and Farms, from Grass and other Rubbish;* Jean Blanc, New Orleans, Louisiana, January 21.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is a scoop, or shovel plough, in combination with the sifter, springs, and cams."

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25. For an *Improvement in the Pin for Fastening Clothing;* James Rabbeth, Mansfield, Connecticut, January 21.

The patentee says,—"The nature of my invention consists in providing a pin with two tubes, (one fastened to the head, and the other to cover the point when used, and removable therefrom at pleasure,) which tubes are connected together by means of an elastic band, in such a manner as to hold and keep the pin in its place, when worn or used, and to prevent the point of the pin from piercing, or otherwise in any manner injuring, the person wearing or using the same."

Claim.—"What I claim as my invention, and what I desire to secure by letters patent, is the combination of the tubes, caps, elastic bands, and pin, as hereinbefore described, so as to form a pin, in such manner as that, when used, the pin will be confined or held in its place, and the point thereof prevented from piercing, or otherwise injuring, the person wearing or using the same."

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26. For an *Improvement in the Faucet and Filter combined, for Purifying Water from Aqueducts, Reservoirs, or Hydrants;* Samuel H. Lewis, City of New York, January 26.

Claim.—"What I claim as my invention, and desire to secure by

letters patent, is the construction of the faucet plug or key, with water channels in its sides, corresponding with the orifice in the water pipe, and with those in the sides of the socket, whereby the direction of the flowing water is occasionally reversed, and made to pass through the filter, in opposite directions; also the combination of the faucet key, and socket, with the filter and filter chambers as described."

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27. For an *Improvement in the Steering Apparatus, or Wheels for Ships, &c.;* Jesse Reed, Plymouth, Mansfield, Massachusetts, January 26.

Claim.—"What I claim as my invention, and desire to have secured to me by letters patent, is the arrangement or combination of two endless screws, (geered together as described,) with a wheel on the top of the rudder post, having teeth on the interior of its rim or periphery, as set forth, and also any contrivances varying therefrom, but substantially the same, and combined substantially in the same manner, and for the same purpose."

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28. For an *Improvement in Planing Planks and Boards;* Job Sheldon, New Haven, Connecticut, January 26.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination and arrangement of the two edged horizontal planing cutters, with the vibrating frame, forked lever, and the connecting rod, constructed and operating substantially as herein described."

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29. For an *Improvement in constructing Presses, for Compressing Bales of Cotton or other Substances;* Alfred C. Jones, New Orleans, Louisiana, January 26.

Claim.—"What I claim as new, and desire to secure by letters patent, is the combination of the link with the arm, and of the latter with the shaft, by which the mechanical effect of the leverage is increased, as the pressing proceeds.

"I also claim the manner of regulating the rise of the follower, to adapt it to bales of different sizes, by a self-adjusting apparatus, consisting of the sliding boxes for the gudgeons of the shaft, the stud, the inclined plane, and the weight and jointed levers, and arranged and operating substantially as set forth."

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30. For an *Improvement in fastening the Tug or Draw Strap of a Harness to the Hames Tug;* William D. Hillis, Cuyahoga Falls, Summit county, Ohio, January 26.

The patentee says,—"The nature of my invention consists in the construction of an apparatus which will serve all the purposes of the common buckle, without the use of the *tongue*, and the consequent necessity of perforating the draw strap with holes, and also the con-

venience of taking up, or adjusting the draw tug, to any desired length."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the application, for the purpose of holding and fastening the tug of a harness, of the plate with the roller, between the tug to be held, and the back plate of the box, in the manner described."

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31. For an *Improvement in Smut Machines;* Joseph Heygel, Baltimore, Maryland, January 26.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is constructing the case of a horizontal smut machine, with two rows of holes in the sides thereof, in the manner described, for ventilating and discharging the smut, and, in combination therewith, the runner, constructed as set forth, for the purposes specified."

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32. For an *Improved method of Traversing Wires across Rivers or Hollows, for the purpose of forming Suspension Cables, for the Support of Bridges;* Jno. A. Roebling, Saxonburg, Pennsylvania, January 26.

Claim.—"What I claim as my original invention, and wish to secure by letters patent, is the application of *traveling wheels*, suspended and worked, either by a double endless rope, or by a single rope, across a river or valley, for the purpose of traversing the wires for the formation of *wire cables*—the whole to be in substance, and in its main features, constructed and worked as described."

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33. For an *Improvement in Metallic Tension Wheels for Carriages, &c., &c.;* James Rowe, Hamilton, Ohio, January 26.

Claim.—"That which I claim as my invention, and desire to secure by letters patent, is, 1st, the centre cylinder, comprising one-third of the whole length of the hub, (more or less,) in combination with the end pieces, and the heads on the inner ends of the spokes.

"2nd, I claim the *swells* at each end of the spoke rods, for the purposes and ends herein described."

We are indebted for the following report to its distinguished author. We publish it for the benefit of future applicants to Congress for renewals of patents, and because it contains a very definite and lucid exposition of a principle which ought to govern in all such cases, but has been heretofore too much neglected. Com. Pub.

Senate U. S.—*Mr. Westcott, from the Committee on Patents and the Patent Office, to whom was referred the petition of Herrick Aicken, praying an extension of his patent for "an improvement in the saw-set," &c., made the following report:*

That a similar petition was presented to the Senate, February 3d, 1845, and referred to the same committee. No law passed in accordance with the prayer of the petition.

The following are the only papers filed with the petition:

1. A paper purporting to be a printed copy of his letters patent and specifications, &c., dated 24th of March, 1833, not certified or otherwise authenticated.

2. A paper purporting to be a printed copy of his protest against the decision of "*the board*" refusing to extend his patent. This appears to have been addressed to Mr. Ellsworth, former Commissioner of Patents, &c., and is dated June 4, 1844. It is not authenticated.

3. A printed schedule of articles stated to be improvements and inventions of the patentee, not authenticated, but of which articles he states specimens are deposited in the Patent Office.

4. A printed handbill or advertisement, with woodcuts of the invention of the petitioner, for which he desires his patent renewed.

The petitioner has neglected to adduce to the committee any evidence whatever, except that furnished by these papers. The testimony before the board, and upon which it refused to extend his patent, has not been laid before the committee, though the petitioner asks that Congress shall in effect, by a special act, *reverse* that decision. Without some *proof* of circumstances showing that petitioner should have granted to him an extension of his patent, as prayed by him, either from considerations of public benefit, or on account of his superior claims from other considerations, Congress should not grant his application. Nor should he expect that the committee will seek to ascertain where the *proofs* of the merits of such application may be found, beyond the testimony filed with the petition, and then to search for, and adduce them. The petitioner must procure and present them with the petition.

Prior to the act of 4th July, 1836, regulating the Patent Office, (vide 5th vol., stat. at large, pp. 117, 124,) patents were extended or renewed only by special act of Congress. Adopting the liberal principles of Lord Brougham's bill amending the patent laws of England, passed in 1835, (vide Kingley's and Prisson's Patent Laws, pp. 77, 79, &c.,) Congress, by the 18th section of the law before cited, made the Secretary of State, the Solicitor of the Treasury, and the Commissioner of Patents a "*board*" to receive applications for the extension of patents, prescribing, with great particularity, the mode of proceeding by the applicant, the character of the testimony he should adduce to the board, and the principles by which it should be guided in the extension of patents.

These provisions are liberal to a patentee who may not have received adequate remuneration or reward for his invention. They are general, embracing nearly every case in which a patent should be renewed.

If cases occur of peculiar character and merit, which, from extraordinary circumstances, may not be within these provisions, and as to which the board have no *power* to grant an extension, and in which the patentee can show grounds for an application to Congress for special relief, it is not denied that Congress may and should extend such relief. Cases may possibly happen, also, in which, though the board had full jurisdiction, its decision, refusing to extend a patent, should not be conclusive upon Congress, and in which upon application of a

patentee, Congress should even disregard such decision of the board, and extend the patent by a special law. But special legislation should always be avoided, except in cases of peculiar and extraordinary merit and necessity. The primary object of the 18th section of the act of 1836, was to provide an impartial tribunal for the decision of such questions upon settled rules and principles, and avoid the necessity of applications to Congress for such special laws. Patentees, having full remedy under the general law, by application to the board, as the law prescribes, should be discouraged from applying to Congress, by a denial of the relief sought, till they resort to such general remedy provided by that general law; and which, it is repeated, is of the most liberal character. It is true, by the constitution of the United States, (vide Art. 1, amendments,) Congress cannot make any law "abridging the right of petition;" but the action of Congress upon petitions unnecessarily or improperly preferred, may, with entire propriety, be such as to discountenance their presentation. It has been urged, that it is not an abridgment of this franchise of petition for the redress of a grievance, public or private, to require that it shall not be prostituted by its use as the medium of proclaiming treasonable, or incendiary, or immoral sentiments, hostile to the constitutional institutions of the country, or libellous with respect to individual citizens, and also to prohibit the use of insulting and disrespectful language towards the body to which it may be addressed; but differences of opinion have existed as to the extent to which such restrictions may be rightfully enforced by Congress. These rules do not, however, apply to the principle just advanced with reference to respectful memorials upon proper subjects, and as to the form, and style, and length of which, the citizen may rightfully consult his own taste and fancy. Either house may, by its rules, prescribe what a petition for the extension of a patent or for any such special law shall set forth, and the character and degree of proof that shall be adduced to entitle it to favorable consideration, even though it may not refuse to *receive* petitions on such subjects not conforming to such rules.

The multiplicity of recent applications to Congress for the extension of patents by special act, has induced the committee to make some suggestions as to the general rules and principles that should govern in regard to such applications, which it may be well for applicants to conform to.

In all cases, a copy of the patent sought to be extended, duly certified, and also of all official documents relating thereto, should be filed with the petition.

In no case where the board has, under the 18th section of the act of 1836, before cited, jurisdiction of an application to extend a patent, and in which no special reasons exist excusing the party for dispensing with such application, should Congress favorably entertain a petition to extend a patent until such jurisdiction has been resorted to. And, where reasons exist for not invoking the action of the "*board*," they should be distinctly stated and proved.

In cases where the board has no jurisdiction, and could not therefore

extend the patent, that fact, and the reasons why the case is not within the jurisdiction of the board, should be clearly shown by applicants.

In all cases in which application has been made to the "*board*," and the extension refused, (as it is sought to rescind the decision of the *board*, and reverse it,) an exemplified copy of the application to the board, and of all the proofs before it, and of all its proceedings, should be filed by the petitioner, and the grounds for the application to Congress for the renewal or extension, should be explicitly and distinctly stated.

In all cases, full proof by affidavit of persons certified to be of good character, and entitled to credit, and disinterested in the matter, should be adduced, substantially as required by the 18th section of the act of 1836, to the following points:

1. As to the value, merits, novelty, and utility of the invention, its cost of manufacture or construction, &c.

2. As to the patentee's receipts and expenditures, respectively, in detail, as far as possible; as to his sales and expenses thereof; and as to the time, trouble, labor, and expense, in bringing his invention into use; and a faithful account of loss and profit in any manner accruing to him from and by his invention.

3. As to any litigation he may have encountered with respect to it, stating the same particularly, and the expenses thereof, and the result thereof.

4. Showing, that without fault or neglect on part of patentee, he has failed to obtain from the use or sale of his invention a reasonable remuneration for his time, ingenuity, expense, labor, trouble, &c., bestowed upon the same, and the introduction thereof into use.

5. As to all transfers or assignments he may have made of such patent right, or of the right to use the thing patented, and showing that such assignees, and others interested, have notice of the application to Congress for such extension, so that injustice may not be done to third persons by their not being apprised of such application, and being therefore without opportunity to oppose such extension. If Congress is without power to prescribe, in advance of such petition, that it will not *receive* it until such full public notice is given, it is not to be doubted that its action upon such petition may, and properly should be, influenced unfavorably, unless full notice is given to the world, and especially to those who may be interested, to dispute the claim of the petitioner to the extension asked. Notice is required by the 18th section of the act of 1836, upon an application for an extension to the "board." As the patent is not conclusive evidence either of the novelty and utility of the thing patented, or that the patentee is the inventor, (vide section 15, act of 1836, *et passim*,) all who may dispute the validity of the patent on such grounds, should have fair opportunity of being heard before the enactment of a special law which may conclude them, and the petitioner should be prepared to show he is the *inventor*.

6. If any special circumstances exist in a case entitling a petitioner

to the favorable consideration of Congress, they should not only be distinctly stated, but *proved.*

7. All papers filed should be legally authenticated.

The absence of the proofs above stated, or disregard of the rules suggested, should, in every case, cause the rejection of an application for an extension.

Elaborately extended statements, essays, arguments, and explanations in writing and letters from public men, or importunate verbal solicitations should not be regarded as supplying the place of *proofs.* In all cases that have been at prior sessions before Congress, the dates should be specifically stated as well as the action had thereon, referring to the Nos. and pages of the documents. The constitutional power of Congress to require by law that petitions of any character, or the testimony to sustain a petition, shall be *printed* in advance of presentation, by a petitioner, may be questioned; but all may understand that the great facility afforded for the speedy examination of a case by the printing of the papers exhibiting its merits, and the furnishing each member with a copy, should be a sufficient incentive to cause an applicant for any relief by special act, to adopt such a course. If they will present petitions written so that it is difficult to decypher them, accompanied by a mass of ill-arranged papers, many often wholly irrelevant, it is not strange that delays arise from the inability of committees and members to examine the cases properly. Applicants may find it beneficial not to disregard this suggestion.

Instances have heretofore occurred in which patents, involving interests to the amount of hundreds of thousands of dollars, have been extended by special act of Congress, and which acts have been complained of as doing injustice to the parties not heard, or whose rights were not considered by Congress. A memorial has, at this very session, been referred to this committee, praying Congress to repeal an act passed in 1845, which extended a patent, in which memorial, signed by sundry citizens of Massachusetts, the express ground is taken, and the express allegation made, that the enactment of the law was procured by "misrepresentation" and by "fraud!" Strict adherence to the rules above suggested, may prevent this accusation being made in future. Another preventive is, the incorporation, in every act extending a patent where there are assignees, of a provision protecting assignees.

The committee, in the particular case under consideration, inasmuch as it does not conform to these rules, and as no evidence has been adduced, report the following resolution:

Resolved, That the prayer of the petition of Herrick Aicken should not be granted.

SPECIFICATION OF ENGLISH PATENTS.

Specification of a patent granted to PAUL GILBERT PRELIER, *of Rue de Rivoli, Paris, in the kingdom of France, for improvements in the manufacture of dry sulphuric acid, and in the manufacture of smoking, or Nordhausen, sulphuric acid,—being a communication.*—[Sealed, 29th June, 1847.]

The patentee commences his specification by stating that, in consequence of the great affinity of sulphuric acid for water, it is difficult to concentrate the acid, even to 66° Baumé; therefore, in order to obtain dry sulphuric acid, he combines simple sulphates with a fresh proportion of acid for the purpose of forming bi-sulphates, which he decomposes by the action of heat, and thus obtains dry sulphuric acid. The manufacture of dry acid naturally leads to the production of smoking or Nordhausen sulphuric acid, as the latter is formed by the addition of dry acid to sulphuric acid, which has been concentrated to 66°,—the specific gravity of the Nordhausen acid increasing with the quantity of dry acid added.

In carrying out the invention, the patentee prefers to employ 100 parts sulphate of soda, 2 parts sulphate of potash, and 2 parts sulphate of lime; but these proportions may be varied; and even if sulphate of soda alone be employed, dry sulphuric acid will be obtained. The mixture is put into freestone retorts, set in a suitable furnace; then, by means of a bent glass tube, the acid is introduced into the retorts, and heat is gradually applied. Shortly after the application of heat, drops of water will proceed from the retorts, then acidulated water, followed by acid at 40°, 50°, and 56°, and finally by acid which fumes or smokes. To enable the operator to judge correctly as to the progress of the operation, vessels containing water are placed to receive the drops of acid; and when each drop produces a sound resembling that which would result if a red-hot iron was immersed in the water, the acid that produces the noise is dry acid. Vessels, to receive the acid, are now placed below the retorts, and luted with clay; and the retorts are subjected to a strong heat, until the acid ceases to drop into the vessels. Dry acid is thus obtained; but if it be desired to obtain Nordhausen sulphuric acid, a quantity of acid, concentrated to 66°, must be introduced into the receiving vessels, when they are placed below the retorts; and, by the admission of the dry acid, the density of the acid in the receiver will be increased to 67°, 68°, and 69°, according to the quantity of dry acid that enters the receiver. By this means sulphuric acid is obtained perfectly clear, and never colored like the Nordhausen sulphuric acid, nor charged with earth or other foreign matters.—[*Inrolled, December,* 1847.]

Lond. Journ. Arts & Sci.

Specification of a patent granted to HARRY JOSEPH PERLBACH, *of the city of Hamburgh, Founder, for an improved method or methods of uniting metals and alloys of metals.*—[Sealed, 23rd July, 1847.]

This invention consists in a method of uniting metals and alloys of metals of different properties and values, as, for example, wrought-iron and cast-iron, copper and cast-iron, &c., whereby compound pieces of metal, suitable for girders, ribs, beams, gudgeons, railway chairs, wheels, axles, and other parts of machinery and mechanical structures, may be produced, possessing all the aggregate weight and cohesiveness required, but much harder and stronger in some parts (such as those exposed to friction or direct strain) than in others.

When it is desired to unite wrought-iron with cast-iron, (for instance, to make a rectangular beam, one-fourth of the thickness of which shall be formed of wrought-iron, and the remaining three-fourths of cast-iron,) the mode of proceeding is as follows:—The piece of wrought-iron is first freed from oxide, by being immersed for a short time in a bath of nitric acid (or any other suitable acid) diluted with water, then taken out, made red hot, and again plunged into the bath. After which, in order to get rid of any acid that may adhere to the iron, it is washed with an alkaline solution; (for example, a solution of sal-ammoniac;) it is then immersed in a bath of melted tin, and left therein until it is well tinned all over. The tinned wrought-iron is next coated on that side where it is to be united to the cast-iron with an alloy or solder, composed of five parts of copper and ninety-five parts of tin: after which, it is placed in a mould, corresponding in form and size with the beam required to be produced, and made fast to the bottom of the same with well-tinned pins and nails; then iron, in a fluid state, is poured upon the wrought-iron, until the mould is filled; and, when cold, the wrought-iron and cast-iron will be found to be firmly united.

Steel is united with cast-iron by the same process as wrought-iron. Copper, or gun-metal, or brass, or any other alloy of copper, is united with cast-iron by similar means to the preceding; but, instead of the surface of the copper or alloy being cleaned by acid and alkaline solutions, this is effected by filing; and the iron is added at a lower degree of heat, so that it may not melt the body of the copper or alloy. When compound pieces of metal of a large size are to be produced, the proportion of copper in the solder, before described, must be increased.

In the above description, the different metals are supposed to be united laterally, or side by side; but one metal may have another united to it on both sides, or be enclosed by it on all sides; and the pieces may likewise be of a curvilinear, angular, or other form,—the mode of casting being varied to suit the circumstances of each case.

The patentee claims, as his invention, the uniting of the different metals and alloys of metals, before particularized, by means of the method or methods, and of the interposed alloy or solder before described.—[*Inrolled, January*, 1848.] Ibid.

Specification of a Patent granted to JAMES NAPIER, *of Shacklewell, in the county of Middlesex, Operative Chemist, for Improvements in smelting Copper Ores.*—[Sealed, July 20, 1846.]

The object of this invention is to facilitate the operation of smelting copper ores, and this the patentee proposes to effect by the application of iron and alkaline substances, and by decomposing and disintegrating the products resulting from such application, by means of water.

If the ores contain less than twenty per cent. of copper, and more than two parts, by weight, of sulphur, to four parts, by weight, of copper, they are first subjected to the ordinary process of calcining and melting, to produce what is termed "coarse metal." If the ores contain less than twenty per cent. of copper and a smaller proportion of sulphur than that above mentioned, other ores, containing sulphur in a larger proportion, must be mixed therewith, in such quantities that the average proportion of sulphur in the mixture will be two parts, by weight, to four parts of copper; and the mixture is then treated in the manner before mentioned for obtaining coarse metal. When the unmixed ores or the mixtures of ores contain more than twenty per cent. of copper, and a greater proportion of sulphur than one part, by weight, to four parts of copper, they are not subjected to the above processes of calcining and melting, but are treated at once in the manner described below for coarse metal.

To each ton of coarse metal, fifty-six pounds of soda-ash, (containing about fifty per cent. of alkali,) and fifty-six pounds of slaked lime are added, and the mixture is put into what smelters term a "metal furnace;" when it is in a state of fusion, any slag that may have formed is skimmed off, and a quantity of scrap-iron is introduced, in the proportion of one hundred-weight thereof to each ton of coarse metal. As soon as this is melted, the whole is well stirred with a rabble, and the furnace being immediately tapped, the fused mass is run into sand moulds. When the contents of the moulds are sufficiently set to be removed, they are put into a shallow pit, containing sufficient water to cover the whole, and allowed to remain therein from two to three hours; by which time the mass will have become partially decomposed and disintegrated. The excess of water is then run off, and the mass removed, and allowed to remain in a heap until the whole is reduced to a fine powder, which will be in about twenty-four hours. The powder is washed in any convenient manner, and introduced into a calcining furnace, in which the heat is gradually increased for twenty hours, so that at the expiration of this time a bright yellow heat will be obtained; and this yellow heat is continued for six hours longer—care being taken to prevent the heat from increasing to such a degree as would cake or fuse the powder, and to stir the powder regularly at intervals during the whole time. The powder is now withdrawn from the calcining furnace, and after being sprinkled with water, according to the ordinary practice, is introduced into a fusing or metal furnace; and for each ton of the powder about

one hundred-weight of pulverized anthracite coal and ten pounds of sand are added; a further addition of a quantity of sand or fluor-spar, as a flux, being made if found necessary. As soon as the whole is well fused, the slag is skimmed off, and the furnace tapped into sand moulds. The product thus obtained is generally fit for the refining furnace; but if a small portion of it should be regulus, this regulus, which is rich in copper, is to be roasted, and afterwards refined. The slag, above mentioned, contains copper, and may be employed as a flux in charges for the ore-furnace, as usual.

The patentee states that he does not confine himself to the above details, as the proportions of the ingredients, the mode of adding the iron and alkaline substances, and the stage at which they are added, and likewise the duration of the processes, may be varied. He has found that potash and its carbonates will produce a similar effect to soda and its carbonates; but the former is more costly. He claims the application of iron with alkaline substances to the smelting of copper ores, and the decomposing and disintegrating, by means of water, the products obtained by such application.—[*Inrolled, January*, 1847.] Ibid.

Specification of a patent granted to JAMES NAPIER, *of Shacklewell-lane, in the county of Middlesex, Operative Chemist, for improvements in smelting copper and other ores.*—[Sealed, 2nd March, 1847.]

This invention consists in improvements in smelting copper ores, by treating them with fluxes, consisting of common salt, lime, and carbonaceous matters; and also in improvements in smelting ores, containing silver, or gold, or both those metals, by the addition of alkaline substances, coal, iron, and galena.

The first object is to facilitate the separation of the earth from the copper; and to effect this, when several ores of different descriptions are to be operated upon, the patentee mixes them in such proportions, in relation to the earthy matters or gangue they contain, as will cause the earths to unite in the furnace and form glass: the ores have been mixed in suitable proportions, when the silica in the mixture ranges from 50 to 75 per cent., in relation to the other earthy matters, which are generally mixtures of alumina, lime, baryta, fluor-spar, &c.,—the presence of oxide of iron greatly facilitates the fusion of the ores. Should the mixture (or the ore, when only one description of ore is being treated) not contain silica in the above proportion, the deficiency is to be supplied by the addition of sand; or, if the silica exceeds the above proportion, lime or fluor-spar is to be added.

After the above preparatory process, the operation is conducted in the following manner:—If the ore or ores should contain not less than 1 part of iron and 1 part of sulphur, to 2 parts of copper, an addition is made to every ton of the ore, of 56lbs. common salt, 40lbs. of slaked lime, and 100lbs. of coal, and the whole is fused in a melting furnace. When fused, the slag or scoria is skimmed off, and the furnace is tapped into sand moulds: the ingots or pigs, thus produced, are treated as

hereafter described. If the ore or ores should contain less than 1 part of iron to 2 parts of copper, the deficiency is to be supplied by the addition of sulphuret of iron; or the ore is to be treated as before mentioned; (omitting the coal;) and after the fused mass has been skimmed, 30lbs. of scrap-iron are to be dispersed over the surface thereof, as equally as possible, and the door of the furnace is closed until the scrap-iron is melted; the furnace is then to be tapped into sand mould. When the ingots, obtained in the above manner, are set, they are thrown into water, whereby they become disintegrated and fall into a fine powder; this powder is thrown into a heap, and allowed to remain for forty-eight hours; after which, it is removed to a calcining furnace, and treated in the manner described in the specification of a patent obtained by the present patentee, July 20, 1846.* The addition of black oxide of manganese, instead of iron, has been found to produce a similar effect, but not with equal advantage.

When ores containing little or no sulphur are operated upon, the above-mentioned processes of disintegration and calcination are omitted. The patentee commences, in this case, by mixing the ores, in relation to their earthy matters, so as to form glass, as above described; (the ores, when containing no iron, might with advantage have a small quantity of oxide or carbonate of iron added;) and then 80lbs. common salt, 50lbs. slaked lime, and 100lbs. anthracite coal, finely pulverized, are added to each ton of ore containing 10 per cent of copper. If the ore should be richer in copper, a smaller proportion of salt and lime will suffice, and a greater proportion of anthracite coal will be required: the patentee says, he has found, that for an ore containing 25 per cent. of copper, 56lbs. common salt, 50lbs. slaked lime, and 150lbs. anthracite coal will answer well. The mixture of ore and other materials is fused in a melting furnace, which, for a charge of 25cwt. of ore, will take from five to six hours; and then the fused mass is tapped into sand moulds: the copper, thus obtained, will generally be ready for the refining operation; but should a portion of the produce be regulus, it is to be roasted, and afterwards refined. Soda and several of its salts may be used instead of common salts; and so likewise may potash and several of its salts, or mixtures of these, free from sulphur.

Sulphuretted ores of copper, containing silver, or gold, or both these metals, are treated in the following manner:—The ore is first calcined and fused, as in the ordinary smelting process, so as to produce a regulus, containing about 50 per cent. of copper; with every ton of this regulus, 56lbs. soda-ash, 40lbs. slaked lime, 1cwt. coal, 1½cwt. iron in scraps, and 4cwts. galena (sulphuret of lead) are mixed, and the mixture is fused in a fusing furnace until the iron disappears; the fused mass is then well rabbled, and tapped into sand moulds. The lead will be found reduced at the bottom of the first and second ingots, and will contain all, or the greater part, of the silver, or gold, or both, which the ore previously contained; these metals are afterwards separated from the lead by the ordinary methods of separating silver and gold from lead. The copper is treated in the ordinary manner, or as de-

* For description of this invention, see Vol. XXX, p. 110, of our present series.

scribed in the specification of the patent before alluded to. Instead of galena, the oxide of lead may be employed; in which case the iron is dispensed with; but the patentee prefers to use galena.

When treating ores of silver, or gold, or both, which do not contain copper, or which do not contain it in the state of a sulphuret, the patentee adds copper pyrites thereto, in the proportion of 4cwts. of the latter to 16cwts. of ore, and then proceeds in the manner above described, viz.: bringing the material into a state of regulus, and fusing it with soda-ash, lime, coal, iron, and galena.

In conclusion, the patentee says, that he does not confine himself to the precise details or proportions of the ingredients used, so long as the peculiar character of the invention be retained.—[*Inrolled, September*, 1847.] Ibid.

MECHANICS, PHYSICS, AND CHEMISTRY.

A Description of Col. Long's Composite Bridge. Secured, March 10, 1845, *and Patented, November* 13, 1847.

(Continued from page 207.)

Remarks of the Patentee, Explanatory of the Nature and Character of the Improvements contemplated in the foregoing Specification, and regarded as New, Useful, and Original.

The improvements under consideration, embrace the following specific objects, viz:

1st. The method of trussing or straining a bridge truss frame as set forth in the specification: which method is of such a character and tendency, that the posts or vertical ties, and the suspensor braces may conjointly and reciprocally perform their respective and appropriate offices or operations (in connexion with other parts of the bridge) either by *tension* or draught, or by *thrust* or pushing, as circumstances may require, or as the stresses in or upon the bridge, produced either by trussing or by the passage of loads on the bridge, may have a tendency to produce, reciprocally and alternately, one or the other of these actions, in the posts and braces.

2nd. The manner of introducing and using the posts or vertical ties as described in the foregoing specification, especially the manner of attaching the same to the upper and lower strings of a bridge truss frame, and in connexion with the posts or vertical ties thereof.

3rd. The manner of introducing and using the main thrust braces, in connexion with movable bolsters, or gluts, as set forth in said specification.

4th. The application and use of movable bolsters, and of movable gluts, at the extremities of, and in connexion with, the main thrust braces, as set forth in said specification.

5th. The introduction and use of keys or wedges, between the posts and the bolsters or gluts, for the purpose of forcing the ends of the main thrust braces, together with the bolsters or gluts, connected therewith, to pass or slide along the strings, whereby the trussing of

the bridge is effected in a manner different from any heretofore adopted.

6th. The application and use of extra braces for the purpose of strengthening and otherwise fortifying the truss frame;—these parts being regarded as highly useful, and beneficial.

7th. The composite bridge as distinguished from all other bridges, by the introduction and use of the several improvements, modifications, and combinations, individually and collectively applied, as set forth and described in the foregoing specification, and more particularly designated in the foregoing remarks, is claimed as a new and useful invention. The application and employment of said improvements, modifications, and combinations, individually and collectively, in the construction of bridge truss frames generally, and of other truss frame work, whether of timber, or of other materials, is also claimed as a new and useful invention.

In regard to the trussing or straining of the bridge, as contemplated in the 1st remark, as above, it should be distinctly understood, that this, as a principle in bridge architecture, was discovered by me in 1828, and patented in 1830.

Its object was, to secure and maintain vertical stiffness or inflexibility in bridges, and to afford the means of reclaiming or straightening, and recambering the spans, of a bridge, in the event of their having sagged or subsided in the parts intermediate to its abutments and piers. The discovery and adaptation of this principle, in so far as it relates to bridge building, is exclusively my own invention.

In the composite bridge, I claim the introduction and use of this same principle, by means of certain new modifications and arrangements in the constituent parts of the truss frames, constituting specific differences, in the manner of applying the principle in question, to structures of this sort, all of which differences have been clearly explained in my specification, and will be at once manifest on a comparison of the drawings and model of said bridge, with those of my former bridges, now in the patent office.

The introduction of this principle is effected by means of sundry new arrangements or modifications, already adverted to, and is attended by divers new combinations, in the stresses or actions of several parts of the truss frame, never before exemplified, as I shall now endeavor to show.

With respect to the reciprocal actions of *thrust*, push or compression, and of *tension*, draft or stretching, in the posts and main suspensor braces, as produced by peculiarities in the construction of the composite bridge, a few explanations are deemed appropriate. These actions are such, that when the former (thrust) takes effect in the posts, the latter (tension) takes effect in the brace, and *vice versa*, when the former takes effect on the brace, the latter takes effect on the post. These actions may be produced either by the passage of a load across the bridge, or by increasing and relaxing the strain imparted by the main thrust braces. No such reciprocal results have ever been or can be produced in the posts and suspensor braces, by any arrangement of their parts heretofore adopted. Similar results might be produced by

causing the ends of the main thrust braces to slide along the posts by means of gluts or bolsters, with wedges driven between the latter and the strings; but, as remarked on a former occasion, the force required to produce the effect by this arrangement, compared with that required to produce the same effect in the composite bridge, will be far greater, while at the same time its application would obviously be more difficult and less convenient in all respects, in the former than in the latter case.

In my suspension bridge, patented in 1839, the main suspensor braces, as also the counter suspensor braces, operate by *tension* only, and the posts by *thrust* only, nor can they impart their efficiency in giving strength to the truss frame, in any other way. In my brace bridge, patented in the same year, the main braces act by thrust only, and the posts by tension only, nor can they strengthen the truss frame in any other way. In my composite bridge, the posts and main suspensor braces are so arranged and adjusted in connexion with the other parts of the truss frame, that both of these parts can, and do, act either by tension, or by thrust, according to circumstances. Some of the circumstances here alluded to as effecting these actions, are as follows, viz :—

1st. When the truss frame is lax, untrussed, or unstrained, by the action of the main thrust braces, or in other words, before the wedges are driven between the bolsters or gluts, and posts, the main suspensor braces will act by tension, and the posts will act by thrust, with or without a load on the bridge.

2nd. When the truss frame is trussed, or strained, by the action of the main thrust braces, or in other words, when the truss wedges have been firmly driven between the bolsters, or gluts, and the posts, the main suspensor braces will act by thrust, and the posts by tension.

3rd. When the truss frame has been trussed, or strained, as in the preceding paragraph, and a load is placed on the bridge, sufficiently heavy to counteract and overcome the action of the main thrust braces after they have been strained, as before mentioned, the main suspensor braces will again act by tension, and the posts by thrust.

4th. The bridge being loaded, as in the preceding paragraph, and the truss wedges being driven again more forcibly between the bolsters, or gluts, and the posts ;—the main suspensor braces will again be brought into action by thrust, and the posts by tension.

To the understanding of the machinist, these results are sufficiently obvious, without mathematical demonstration.

Thus has it been shown that all the claims, from the 1st to the 5th inclusive, relate to co-operative principles, or actions taking effect, or rendered efficient in the composite bridge : and that these several principles may operate conjointly, as well as separately, in imparting strength and efficiency to the structure.

I shall now attempt to show how the extra braces perform their part in "strengthening and otherwise fortifying the truss frame."

These braces rise from the lower strings within an abutment, or pier panel, and terminate at the upper strings, within the next adjacent panel ;—and from the lower string, at the insertion of a suspen-

sor brace, to the upper string at the insertion of the suspensor brace for the next adjacent panel, counting from the abutment, or pier, and so on for the other panels.

The extra brace first mentioned, imparts its efficiency, in aid of sustaining the bridge, and its load, at the pier, or abutment. Its efficient action is ensured, not only by the resting of the upper string on its head, but by its attachment to the head of the main suspensor brace, by trenails. All other extra braces perform their offices by means of attachments, or connexions, similar to that last mentioned, both at the head, and at the foot, of the main suspensor braces. By means of their connexion with these braces, and with the strings, the extra braces last mentioned, operate by stresses similar to those to which the posts are subjected: that is to say, when the posts act by *thrust*, the extra braces will act by thrust, and whenever the posts act by *tension*, the extra braces will act by tension; thus relieving the posts and their fastenings from an amount of action, which might otherwise prove greater than they are able to bear.

The extra braces contribute also to impart lateral stiffness to the posts, which may be needful, in the event of extraordinary thrust or compression in the latter.

Moreover, on driving the truss wedges or keys, the bolsters or gluts connected with them are removed farther from the ends of the posts, and of course, the points, at which the thrust of the main thrust braces is received upon the strings, are at the same time removed farther from the posts. Hence the thrust of the main thrust brace, will have a tendency to spring or force outward the string on one side of the post, while the tendency or counter strains on the other side of the post will be inward, and in consequence will be met, counterpoised, and resisted by the extra brace.

Hence, although the extra braces may not be regarded as essential, they cannot be viewed in any other light than that of subserving the purposes for which they are intended, viz: "of strengthening and otherwise fortifying the bridge."

Thus has it been shown that all the improvements and modifications claimed by me as new and original, are individually embraced and collectively co-operative in the composite bridge, and are all instrumental in imparting strength, efficiency, and inflexibility, to the bridge, in a way never before adopted in bridge building. The 7th remark has been added for the purpose of showing that I possess the right of employing these several improvements individually, or collectively, in bridge building, and in all other structures, whether of wood, iron, or other materials, in which truss frames are deemed appropriate, as component parts of the work.

Directions to Builders of the Composite Bridge.

Under this head there remains very little to be added to what has already been advanced in a former part of this treatise, in relation to the construction of the brace and suspension bridges, the parts, dimensions, and proportions of one or the other of which, are similar in most respects to those of the composite bridge. The following parts,

however, may be regarded as peculiar to the bridge last mentioned, and of course are entitled to particular notice.

I.—*Of the Posts or Vertical Ties.*

These parts may have the same transverse dimensions as other parts of the truss frame, and should be of such length as to extend outward about nine inches beyond the strings, both upward and downward. The ends of the posts above and below the strings, should be scarfed in a manner to be in close contact with the ends of the suspensor braces. The posts are inserted in the spaces situated between the string pieces, and are firmly connected thereto by trenails, as represented in the drawings.

II.—*Of the Main Thrust Braces.*

These braces differ from those of the brace bridge in the number of pieces of which they are respectively composed, each brace containing one piece more in the composite than in the brace bridge. Moreover, instead of abutting against shoulders in the posts, as in the latter, they abut against movable bolsters; or in cases where gluts are used instead of bolsters, these braces abut partly against the strings, and by means of the gluts, partly against the posts.

The main thrust braces, together with their bolsters or gluts, &c., may be prepared and fitted, whilst the framing of the bridge is in progress, but need not be inserted in the bridge till its ribs, or truss frames, shall have been put up at the bridge site.

The ends of the main thrust braces may be confined to the bolsters by means of spikes or nails, should such fastenings be deemed proper; —but when these braces are used in connexion with gluts, they will be sufficiently bonded by the trenails employed on such occasions.

III.—*Of the Brace Bolsters.*

These parts should be made of well seasoned oak, or other hard timber, dressed to the size of about six by eight inches, and cut into lengths exceeding the entire width of the string by about three inches, one of the broader sides of the bolster is applied to the strings, and one of the narrower sides to the posts, in alternate angles of each panel. The inner angle is terminated in such a manner as to present a surface about nine inches wide, and at right angles to the main thrust brace, against which the latter abuts. Each bolster should be furnished with recesses, made in its back, for the admission of the brace keys, or wedges, the slope or taper of the recesses, and of the keys, being about in the ratio of 1 to 12. The number of the recesses in each bolster, as also the number of the keys, should be the same as the number of pieces of which the post is composed. The slopes of the recesses should be a little more abrupt than those of the keys, in order to ensure a stress somewhat greater at the base, than at the top or opposite side of the bolster; whereby the driving of the keys will have a tendency to keep the oblique face of the bolster perpendicular to the brace.

IV.— *Of the Gluts, &c.*

The form and dimensions of these parts, and the positions of the trenails, by which they are confined in their places, as also the forms and positions of the brace keys connected therewith, are represented with sufficient clearness in the drawings. The timber of which they are composed is similar to that of other parts of the truss frame.

V.—*Of the Brace Keys, or Wedges.*

These parts should be constructed of well seasoned oak, locust, or other unyielding and durable timber. Their length should be two to three feet, their thickness equal to that of a post or suspensor brace timber, and their slope, as before stated, about in the ratio of 1 to 12. They may be applied in such a manner, as that they may be driven either upward or downward, as may be found most convenient.

VI.—*Of the Trenails.*

Among the various parts of the composite bridge, none requires greater care and precision in their adjustment, than the numerous trenails required in its construction. They should be made of straight-grained, tough, and well seasoned oak, locust or other hard and durable timber, and should be of a size and form, adapted with precision to the holes made for their reception. The number of the trenails, at the several places where they are required, should be as represented in the drawings, viz: six, at every intersection of a string and main suspensor brace; four or six at every intersection of a string and post; four at each glut; two at every intersection of an extra brace and suspensor brace; and ten at every splice of the string pieces;—besides which screw bolts of ¾ inch iron should be applied, as clamps, at the following points, viz: one at every intersection of a main suspensor, and a main thrust brace; one at every intersection of a post and extra brace; and four at or near the angles or corners of each outside splicing piece.

The size of the trenails should correspond in some degree, with the transverse dimensions of the timbers through which they are to pass. When the transverse dimensions of the timbers are 1¼ by 8 inches, the diameter of the trenails should be about one inch. Timbers 2 by 10 inches, require trenails about 1¼ inch in diameter;—3 by 12 inches, 1½ inch in diameter;—3 by 14 inches, 1¾ inch in diameter;—4 by 14 inches, 2 inches in diameter. The lengths of the trenails should be such, that both ends respectively, may protrude about half an inch beyond the timbers through which they are driven.

The method of preparing bridge trenails, suggested in a former part of this treatise, has been found objectionable, for the following reasons. The successive impacts of the mallet, applied for the purpose of driving the trenails through the cutter, cannot all be given precisely in the same direction. Hence, it results, that the trenail, besides being crooked, is more or less ribbed at the extremity of each movement, communicated respectively by the impacts. In consequence both of the ribs and crooks thus produced, the facility of driving the trenails into the timbers of the bridge, as also their efficiency when driven, are much impaired.

Moreover, the process of driving the trenail through the cutter, is often attended by the production of spalls, splits, or exfoliations from the body of the trenail, whereby its sides are frequently rendered lean and defective, and its bearings and efficiency greatly impaired.

These evils may be effectually remedied, by forming the trenails in a slide lathe, properly adjusted for this purpose. By this means, trenails may be made of uniform sizes, and with straight, smooth, and equable surfaces, adapted in all respects to the holes in which they are to be inserted. Their appropriate lengths being previously determined, their extremities may be rounded into a hemispherical form, whereby their appearance when applied to the bridge, may be rendered, in no small degree, ornamental.

With respect to the holes perforated for the reception of the trenails, they should be formed by the use of augers of the best kind, or furnished with cutters so adjusted, as to render the holes when bored, perfectly round, straight, and smooth, on all sides. The trenails should snugly and completely fill the holes, and should never be so large as to impart a lateral or splitting strain to the timbers in which they are inserted.

Finally, the lateral and transverse bearings, the side arch bracings, the inferior arch bracings, the flooring, the roofing and sheathing, the splicings of the strings, the bolsters and bolster frames, the trustle piers, &c., &c., in so far as they relate to the composite bridge, are to be constructed and applied in the manner prescribed under the head of "directions to bridge builders" in the former part of this treatise.

Mistakes of a serious nature having occurred in a few instances, in consequence of inserting the splicing of the strings in immediate connexion with the posts, it is proper on this occasion to caution the bridge builder against the commission of any similar mistake, in his future operations. The splicing of the strings should always be located about midway of the panel, so that the spliced string pieces may abut at equal distances from the posts, by which the vertical sides of the panel are bounded. For it is manifest, that when the splicings occur at the posts, no splicing pieces can be inserted between the parts of the string, and consequently that the strength and efficiency of the string will be seriously impaired. The points at which the string pieces abut, should be located midway between the posts of the panel.

Objections to the Theories severally of Franklin, Dufay, and Ampere, with an effort to explain Electrical Phenomena, by Statical, or Undulatory, Polarization. *By* ROBERT HARE, M. D., *Emeritus Professor of Chemistry in the University of Pennsylvania.*

(Continued from page 199.)

The extreme diversity, as respects striking distance, between the direct effects of Frictional Electricity and those directly arising from Galvanic Reaction.

46. The intensity of the excitement produced by different electri-

cal machines, is estimated to be as the relative lengths of the sparks which proceed from their prime conductors respectively. Admitting that the relative intensity were merely as the length of the spark, not as the square of that length, still there would be an infinite difference between the intensity of a voltaic series and that of electrical machines, if measured by this test. Large electrical machines, like that at the Polytechnic Institution, London, give sparks at twenty inches and more; while agreeably to Gassiot's experiments, a Groves battery of 320 pairs, in full power, would not, before contact, give a spark at *any distance, however minute.* It follows, that, as respects the species of intensity which is indicated by length of sparks, or striking distance, the difference between the electricity of the most powerful voltaic series and electrical machines, is not to be represented by any degree of *disparity;* it proves that galvanism proper and electricity proper are heterogeneous.

47. It should be recollected that the intensity of galvanic action, in a series of 320 pairs, excepting the loss from conduction, would be to that of one pair as 320 to 1.* Of course, the striking distance of a battery of one pair would be 320 times less than nothing : 320 below zero.

48. We may infer that the undulatory polarization of ethereo ponderable matter, is the primary, direct, and characteristic, effect of galvanic excitement, in its more energetic modifications. Yet, that by peculiar care in securing insulation, as in the water batteries of Crosse and Gassiott, ethereal undulations may be produced, with the consequent accumulation of ethereal polarity requisite to give sparks before contact, agreeably to the experiments of those ingenious philosophers.

49. Hence it may be presumed, that during intense ethereo-ponderable polarization, superficial ethereal waves may always be a collateral effect, although the conducting power of the reagents, requisite to the constitution of powerful galvanic batteries, is inconsistent with that accumulation of ethereal polarity which constitutes a statical spark-giving charge.

50. As all the members forming a voltaic series have to be discharged in one circuit, the energy of the effort to discharge, and the velocity of the consequent undulations must be, ceteris paribus, as the number of members which co-operate to produce the discharge. Of

* According to Colomb's experiments, electrical attraction and repulsion are inversely as the squares of the distances, and the inductive power of statical charges which is produced by those forces, and which precedes and determines the length of the resulting spark, must, of course, obey the same law.

If this calculation be correct, the intensity must be as the squares of the striking distances, as indicated by sparks.

It may be urged, that the striking distances, as measured by the length of the sparks, is in the compound ratio of the quantity and intensity. As to the quantity, however, galvanic sources have always been treated as pre-eminent in efficacy, so that on that side there could be no disparity. Moreover, I have found, that in galvanic apparatus of only one, or even of two pairs, as in the calorimotors, the intensity lessened as the surfaces were enlarged. By a pair of fifty square feet, of zinc surface, a white heat could not be produced in a wire of any size, however small. The calorific power of such apparatus can only be made evident by the production of a comparatively very low temperature, in a comparatively very large mass.

course the more active the ethereo-ponderable waves, the greater must be their efficacy in producing ethereal waves of polarization, as a secondary effect, agreeably to the suggestions above made. (49, 36.)

51. Hence in a battery consisting of one galvanic pair excited by reagents of great chemical energy, and conducting power, the electromagnetic effects are pre-eminent; while De Luc's electric columns consisting of several thousands of minute pairs, feeble as to their chemical and conducting efficacy, are pre-eminent for statical spark-giving power. (48.) This seems to be quite consistent; since on the one hand, the waves of polarization must be larger and slower, as the pairs are bigger and fewer; and on the other hand smaller and more active, as the pairs are more minute and more numerous.

On the perfect similitude between the Polarity communicated to Iron Filings by a Magnetized Steel Bar, and a Galvanized Wire.

52. If by a sieve, or any other means, iron filings be duly strewed over a paper, resting on a bar magnet, they will all become magnets, so as to arrange themselves in rows like the links of a chain. Each of the little magnets thus created, will, at its outermost end, have a polarity similar to that of the pole (of the magnet) with which it may be affiliated. Of course the resulting ferruginous rows, formed severally by the two different poles of the bar, will have polarities as opposite as those of the said poles.

53. In an analogous mode, if two wires be made the media of a galvanic discharge, iron filings, under their influence, will receive a magnetic polarity, arranging themselves about each wire like so many tangents to as many radii proceeding from its axis. Those magnetized by one wire reacting with such as are magnetized by the other.

54. The affections of the ferruginous particles during the continuance of the current so called, are precisely like those of the same particles when under the influence of the bar magnet. The great discordancy is in the fact, that the influence of the magnet is permanent, while that of the wire is indebted for existence to a series of oppositely polarizing but transient impulses which proceed towards the middle of the circuit from each side, so as to produce reciprocal neutralization by meeting midway.

55. The effect upon the filings, as originally pointed out by Oersted, is precisely such as would arise were the ponderable matter of the wire resolved by each impulse into innumerable little magnets, situated so as to form tangents to as many radii proceeding from the axis of the wire.

56. Independently of the filings, the wires react with each other as if their constitution, during subjection to the discharge, were such as above supposed. When the discharges through them concur in direction, they attract, because the left side of one is next the right side of the other, bringing the opposite poles of their little magnets into proximity; but when the discharge is made in opposite directions, the two right or the two left sides will be in proximity, and will, by the

consequent approximation of the similar poles of the little magnets, be productive of repulsion.

57. From these last mentioned facts and considerations, it must be evident that, assuming that there is in a galvanized wire a derangement of the poles of the constituent ethereo-ponderable particles analogous to that permanently existing in magnetized steel, involves no contradiction, no absurdity, nor any thing but what is consistent with the researches and inferences of Davy, Faraday, and other eminent investigators of the phenomena of nature.

Process by which the Ethereo-ponderable Atoms within a Galvanic Circuit are Polarized by the Chemical Reaction.

58. In order that an ethereo-ponderable particle of oxygen in any aqueous solution shall unite with an ethereo-ponderable particle of zinc in a galvanic pair, there must be a partial revolution of the whole row of ethereo-ponderable zinc atoms, with which the atom assailed is catenated by the attractions between dissimilar poles. Moreover, at the same time that the metallic atoms are thus affected, the atoms of water between the metallic surfaces must undergo a similar movement, by an analogous reaction with poles of an opposite character, and this movement must extend through the negative plate to the conductor, by which it communicates with the zinc or electro-positive plate. When the circuit is open, the power of combination exercised by the zinc and oxygen is inadequate to produce this movement in the whole chain of atoms, liquid and metallic ; but as it is indifferent whether any two atoms are united with each other, or with any other atoms of the same kind, the chemical force easily causes them to exchange partners, as it were, when the whole are made to form a circuitous row in due contiguity.

59. As we know that during their union with oxygen, metals give out an enormous quantity of heat and electricity, it is reasonable to suppose that whenever an atom of oxygen and an atom of zinc jump into union with each other, a wave is induced in the ethereo-ponderable matter, and that this wave is sustained by the decompositions and recompositions by means of which an atom of hydrogen is evolved at the negative plate, and probably enabled to assume the aëriform state. There must, at the same time, be a communication of wave polarity by contact of the negative plate with the connecting wire, by which the positive wave in the wire is induced. Although the inherent polarities of the metals are not, agreeably to this view, the moving power in galvanism, yet they facilitate, and in some cases induce the exercise of that power, by enabling it to act at a distance, when otherwise it might remain inert.

60. This, I conceive, is shown in the effect of platina sponge upon a mixture of the gaseous elements of water ; also in Groves' *gas* battery, by means of which hydrogen and oxygen gas severally react with water in syphons, so as to cause each other to condense, without any communication besides that through the platina, and an electrolytic decomposition and recomposition extending from one of the

aqueous surfaces in contact with one of the gases, to the other surface in contact with the other gas.

Difference between Electro-ethereal and Ethereo-ponderable Polarization.

61. There are two species of electro-polarity which come under the head of statical electricity. One of these Faraday illustrates by supposing three bodies, A, B, and C, in proximity, but not in contact, when A, being electrified, electrifies B, and B electrifies C by induction. This Faraday calls an *action* of the particles of the bodies concerned, whereas, by his own premises, it appears to me to be merely a superficial affection of the masses or of a circumambient ethereal matter. This species of polarization, to which the insulating power of air is necessary, affects the superficies of a body only, being displayed as well by a gilt globe of glass, as a solid globe of metal. No sensible change appears to be produced in the ponderable conducting superficies by this inductive superficial electrification of masses; and of course no magnetism.

62. When a small image, of which the scalp has been abundantly furnished with long hair, is electrified, the hairy filaments extend themselves and move apart, as if actuated by a repulsive power, also when iron filings are so managed as to obey the influence of the poles of a powerful magnet, (51,) they arrange themselves in a manner resembling that of the electrified hair. There is, moreover, this additional analogy, that there is an attraction between two portions of hair differently electrified, like that which arises between filings differently magnetized. Yet the properties of the electrified hair and magnetized filings are, in some respects, utterly dissimilar. A conducting communication between differently electrified portions of hair would entirely neutralize the respective electrical states; so that all the electrical phenomena displayed by them would cease. Yet such a communication made between the poles, exciting the filings, by any non-magnetic conductor, does not in the slightest degree lessen their polar affections and consequent power of reciprocal influence. Upon the electrified hair, the proximity or the contact of a steel magnet has no more effect than would result under like circumstances from any other metallic mass similarly employed; but by the approximation, and still more, the contact, of such a magnet, the affection of the filings may be enhanced, lessened, or nullified, according to the mode of its employment. In the case of the hair, the affection is superficial, and the requisite charging power must be in proportion to the extent of surface. In the case of the magnetized ferruginous particles, it is the mass which is affected, and, ceteris paribus, the more metal, the greater the capacity for magnetic power. In the instance of the electrified hair, as in every other of frictional excitement, the electrical power resides in imponderable ethereo-electric atmospheres which adhere superficially to the masses, being liable to be unequally distributed upon them in opposite states of polarity, consequent to a superficial polarization of the exciting or excited ponderable masses; but in the instance of bodies permanently magnetic, or those rendered tran-

siently magnetic by galvanic influence, the ethereo-electric matter and the ponderable atoms are inferred to be in a state of combination, forming ethereo-ponderable atoms; so that both may become parties to the movements and affections of which the positive and negative waves consist.

63. Thus an explanation is afforded of the hitherto mysterious diversity of the powers of a gold leaf electroscope and galvanoscopes, although both are in a miraculous degree sensitive; the latter to the most feeble galvanic discharge, the former to the slightest statical excitement; yet neither is in the most minute degree affected by the polarization which affects the other.

64. The charge which may exist in a coated pane affords another exemplification of statical or electro-ethereal polarity. In this case, according to Faraday, the particles of glass are thrown into a state of electro-polarity, and are, in fact, partially affected as if they belonged to a conductor; so that insulators and conductors differ only in the possession in a high degree by the one, of a susceptibility of which the other is possessed to an extent barely perceptible. The facts seem to me only to show, that either an insulator or conductor may be affected by the same polarizing force, the transmission of which the one facilitates, the other prevents. I am under the impression that it is only by the disruptive process that electricity passes through glass; of course involving a fracture. It gets through a pane or jar, not by aid of the vitreous particles, but in despite of their opposing coherence. The glass in such cases is not liable to be fused, deflagrated, or dissipated, as conductors are. It is forced out of the way of the electrical waves, being incapable of becoming a party to them. Discharges will take place through a vacuity, rather than through the thinnest leaf of mica. But if, as Faraday has alleged, from within a glass flask hermetically sealed, an electrical charge has been found to escape, after a long time, it proves only that glass is not a perfect insulator, *not that perfect insulation and perfect conduction are different extremes of the same property.* On the contrary, the one is founded upon a constitution competent to the propagation within it of the electro-polarizing waves, with miraculous facility, while the other is founded either on an absolute incapacity, or comparatively an infinitely small ability, to be the medium of their conveyance. The one extremely retards, the other excessively expedites, its passage through a space otherwise void.*

Competency of a Wire to convey a Galvanic Discharge is as its sectional area, while statical discharges of frictional electricity preferring the surface are promoted by its extension. Yet in proportion as such discharges are heavy, the ability of a wire to convey them and its magnetic energy become more dependent on its sectional area and less upon extent of surface.

65. Reference has been made to two modes of electrical conduction,

* By a void, I mean a Torricellian vacuum. The omnipresence of the electro-ether must render the existence of a perfect void impossible.

in one of which the efficacy is as the surface; in the other, as the area of a section of the conductor. Although glass be substantially a non-conductor, the power of the surface of glass when moistened, or gilt, to discharge statical electricity, is enormous. It has been generally considered, that as a protection against lightning, the same weight of metal employed as a pipe, would be more efficacious than in the usual solid form of a lightning rod: yet this law does not hold good with respect to galvanic discharges, which are not expedited by a mere extension of conducting surface. Independently of the augmentation of conducting power, consequent to radiation and contact with the air, the cooling influence of which, according to Davy, promotes galvano-electric conduction, a metallic ribbon does not convey a galvanic discharge better than a wire of similar weight and length.*

66. Agreeably to the considerations above stated, the sectional area of a conductor remaining the same, in proportion as any *statical* accumulation which it may discharge is greater, the effects are less superficial; and the ethereo-ponderable atoms are affected more analogously to those exposed to galvanic discharges. It is in this way that the discharge of a Leyden jar imparts magnetic polarization. Thus, on the one hand, the electro-ethereal matter being polarized and greatly condensed, combines with and communicates polarization, and consequently magnetism, to ethereo-ponderable bodies; while on the other hand, these, when polarized by galvanic reaction, and thus rendered magnetic, communicate polarity to the electro-ether. Hence statical electricity, when produced by galvanism, and magnetism, when produced by statical electricity, are secondary effects.

67. Where a wire is of such dimensions, in proportion to the charge, as to be heated, ignited, or dispersed by statical electricity, there seems to be a transitory concentration of the electric power, which transforms the nature of the reaction, and an internal wave of ethereo-ponderable polarization, similar to those of galvano-electricity, is the consequence.

68. As above observed, (31,) the current produced by the magneto-electric machine, has all the attributes of a galvano-electric current: yet this is altogether a secondary effect of the changes of polarity in a keeper, acting upon a wire solely by dynamic induction. But if, by mere external influence, the machine above mentioned can produce within a circuit a current such as above described, is it unreasonable to suppose that the common machine, when it acts upon a circuit, may put into activity the matter existing therein, so as to produce

* It is well known that Wollaston effected the decomposition of water by the aid of a powerful electrical machine. Having enclosed platina wires within glass tubes, these were fused so as to cover the ends. The glass was afterwards so far removed, by grinding, as to expose minute metallic points to the liquid. Under these circumstances, the electricity conveyed by the wires, being prevented from proceeding over them superficially, was obliged to make its way through the ethereo-ponderable matter of which metals consist. (38.) Instead of proving the identity of galvanism with frictional electricity, (note 39,) this experiment shows that in one characteristic at least there is a discordancy. At the same time it may indicate that ethereal may give rise to ethereo-ponderable undulations.

waves of polarization, having the power of those usually ascribed to a galvano-electrical current?

69. It has been shown that both reason, and the researches and suggestions of Faraday, warrant the inference, that ponderable atoms, in solids and liquids, may be considered as swimming in an enormous quantity of condensed imponderable matter, in which all the particles, whether ponderable or imponderable, are, in their natural state, held in a certain relative position due to the reciprocal attraction of their dissimilar poles. A galvano-electrified body differs from one in its ordinary state, in having the relative position of the poles of its ethereo-ponderable atoms, so changed, that their inherent opposite polarities not being productive of reciprocal neutralization, a reaction with external bodies ensues.

70. In statical excitement the affection is superficial as respects the ponderable bodies concerned, while in dynamic excitement the polarities of the whole mass are deranged oppositely at the different ends of the electrified mass; so that the oppositely disturbing impulses, proceeding from the poles of the disturbing apparatus, neutralize each other intermediately. Supposing the ponderable as well as the imponderable matter in a perfect conductor, to be susceptible of the polar derangement, of which an electrified state is thus represented to consist, non-conductors to be insusceptible of such polar derangement; imperfect conductors may have a constitution intermediate between metals and electrics. When an electrical discharge is made through any space devoid of air or other matter, it must then find its way solely by the polarization of the rare imponderable matter existing therein; and consequently its corruscations should be proportionably more diffuse, which is actually found to be true; but when gaseous ethereo-ponderable atoms intervene, they enable competent waves to exist within a narrower channel, and to attain a greater intensity. I consider all bodies as insulators which cause discharges through them to be more difficult than through a vacuum, and which, by their interposition within a circuit, can prevent that propagation of the oppositely polarizing undulations which would otherwise ensue. This furnishes a good mean of discrimination between insulators and conductors, the criterion being, that a discharge ensues more readily as there is more of the one and less of the other in the way: that the one leads the waves where they would not go, the other impedes their going where they would proceed. Both in the case of diruptive discharge through air, producing a spark, or of a deflagrating discharge through wire, causing its explosion, there is a dispersion of intervening ponderable particles: and yet there is this manifest discordancy, that in one case the undulatory process of transfer is assisted, in the other resisted. The waves follow the metallic filament with intense attraction, while they strive to get out of the way of those formed by the aëriform matter, as if repelled. Hence the term diruptive, from *dirumpo*, to break through, was happily employed by Faraday to designate spark discharges. The zigzag form of the diruptive spark, shows that there is a tendency in the aëriform particles to turn the waves out of that straight course, which, if unresisted or facilitated, they would natu-

rally pursue. On the one hand the aërial filaments being unsuitable for the conveyance of the electric waves, these are forced by them out of the normal path, first in one direction, then in another; while on the other hand, the finest metallic filament furnishes a channel for the electric waves, so favorable that this channel is pursued, although the consequent polarization of the conducting particles be so intense as to make them fly asunder with explosive violence. Even when a bell wire has been dissipated by lightning, it has been found to facilitate and determine the path of the discharge.

71. The various forms of the electric spark, resulting from varying the gas through which it may be made to pass, agreeably to the researches of Faraday, are explained by the supposition that the peculiarities of the spark are partially the consequence of the polarizability of the gaseous atoms through which the discharge is made, and vary accordingly in their appearance.

Difference between Frictional Electricity and Galvanic, does not depend on the one being superior as to quantity, the other as to intensity; but on the different degrees in which the Ethereo-ponderable Atoms of the bodies affected, are deranged from their natural state of Neutralized Polarity.

72. I infer that all magneto-polar charges are attended by an affection of ponderable particles; and that the reason why the most intense statical charge does not affect a galvanometer, is, that it is only when oppositely excited bodies are neutralized by the interposition of a conductor, as during a discharge, that ethereo-ponderable particles are sufficiently polarized to enable them to act upon others in their vicinity, so as to produce a polar affection the opposite of their own. In this way dynamic induction is consistently explained, by supposing that the waves of polarization, in passing along one conductor, produce, pari passu, the opposite polarization in the proximate part of any neighboring conductor suitably constituted, situated and arranged to allow it to form a part of a circuit.

73. It is only during the state of the incessant generation and destruction of what has been called the two electricities, that the circuit, which is the channel for the passage of the polarizing waves, is endowed with electro-magnetic powers. It was, no doubt, in obedience to a perception of this fact, that Oersted ascribed the magnetism of a galvanized wire to a conflict of the electricities. Undoubtedly that state of a conductor in which, by being a part of an electrical circuit, it becomes enabled to display electro-magnetic powers, is so far a conflict of the two electricities, as the affections of matter, which are denominated electrical, consist of two opposite polar forces, proceeding, agreeably to the language of Faraday, in opposite directions from each side of the source, and conflicting with each other so as to be productive of reciprocal annihilation.

74. That a corpuscular change in conductors is concomitant with their subjection to, or emancipation from, a galvanic current, is proved by an experiment of Henry's, which he afforded me an opportunity,

on one occasion, of witnessing. I allude to the fact that sound is produced whenever the circuit is suddenly made or suddenly ruptured.

By I. P. Mairran it has been observed, that a similar result takes place during the magnetization of iron rods, by the alternate establishment or arrestation of galvanic discharges through wires coiled about them so as to convert each into an electro-magnet. Mr. Mairran represents the sound as resembling that produced by striking a rod upon one of its ends.* † Sounds from this source were observed by Dr. Page in 1838. See Silliman's Journal for that year, Vol. 33.

75. Thus it appears that there is an analogy between the state of matter which involves permanent magnetism, and that which constitutes a galvanic current, so far as this; that either by one or the other, during either its access or cessation, an affection of the ponderable particles concerned ensues, sufficient to produce sound.

76. Simultaneously with the production of sounds as above stated, by the opening or closing of the galvanic circuit through a metallic rod or the coils of an electro-magnet, secondary waves are induced, called secondary currents. It seems reasonable to ascribe these waves to the same shifting of the poles, which produces the sonorific undulations.‡

* Agreeably to recent experiments of Faraday, the particles of a glass prism may be so influenced by an electro-magnet as to affect the passage of polarized light.

† L. and E. Phil. Mag. and Jour., Vol. 45, p. 383, 1844.

‡ These phenomena excite more interest in consequence of the employment, for medical purposes, of an apparatus originally contrived by Callan, but since ingeniously modified by our countryman, Dr. Page, into a form which has been designated as the electrotome. A coil of coarse copper wire, covered with cotton, like bonnet wire, is wound about a wooden cylinder. Around the coil thus formed, a coil of fine copper wire similarly covered is wound, leaving the extremities accessible. One end of the coarse coil communicating constantly with one pole of a galvanic battery, the other end is left free; so that by scraping with it, the teeth of a rasp attached to the other pole, a rapid closing and opening of the circuit may be effected. Under these circumstances, an observer, holding the ends of the fine coil, receives shocks more or less severe, according to the construction of the battery, the energy of the agents employed to excite it, or the total weight and relative dimensions of the coils, as to length and sectional area. Agreeably to the received doctrine, the shocks thus produced, are owing to secondary currents caused by dynamic induction. Agreeably to the hypothesis, which I have advanced, the atoms of the coarse wire, polarized by waves proceeding from the poles of the battery, induce a corresponding polarization of the atoms of the fine wire; the aggregate polarity imparted, being as the number of atoms in the former to the number of atoms in the latter: or, (to use an equivalent ratio,) as the weight of the coarse, to the weight of the fine wire. But as on breaking the circuit, through the coarse wire, the ethereo-ponderable atoms in both wires resume their neutral positions, while this requires each circuit to be run through within the same minute interval, the velocities of their respective waves will be inversely as their sectional areas and directly as their lengths: in other words, the velocity in the fine wire will be as much greater, as the channel which it affords is narrower and longer. The cylinder, included within the coils as above stated, being removed, a cylindrical space is vacated. If into the cavity thus made, iron rods, like knitting needles, be introduced, one after the other, while the apparatus is in operation, the shocks increase in severity as the number of needles introduced augments; so that from being supportable they may be rendered intolerable. The shock takes place without the presence of iron, but is much increased by its assistance.*

* Agreeably to the usual construction, the cylinder about which the inner coarse wire coil is wound is originally of iron, so that there is as much of this metal contained as it can hold. Various contrivances are resorted to for the closing and opening of the circuit, which are more ingenious and convenient than scraping a rasp, as above described.

77. Within the bodies of animals and vegetables, the electro-ether may be supposed to exist as an atmosphere surrounding the ethereo-ponderable atoms of which their organs are constituted, so as to occupy all the space which is not replete with such atoms. Hence a discharge of frictional electricity may indirectly polarize the whole animal frame, by producing ethereo-ponderable polarization in the constituent atoms of the fibres of the nerves and muscles. Probably this polarization is produced more immediately in the ponderable solids, by a discharge from a voltaic series, or a wire subjected to electro or magneto-dynamic induction. In the latter instances the shock is reiterated so rapidly as to appear more enduring, while in the former, it is more startling and producible at an infinitely greater distance.

78. Agreeably to Faraday's researches, (1485 to 1543,) there is reason to suppose that in frictional spark discharges, the consequent shock, light, and other peculiarities, are in part owing to waves of ethereo-ponderable polarization, indirectly produced in the intervening gaseous matter. (71.)

Of Ethereo-ponderable Deflagration.

79. It is well known that between two pieces of charcoal severally attached, one to the negative, the other to the positive pole of a numerous and well excited voltaic series, an arch of flame may be produced by moving them apart after contact. This phenomenon evidently depends upon the volatilization of the ponderable matter concerned; since it cannot be produced before the carbon has been volatilized by contact, nor by any body besides charcoal, this being the only conductor which is sufficiently infusible, and yet duly volatilizable. Metals, similarly treated, fuse at the point of contact and cohere. On separation, after touching, a single spark ensues; which, without repetition of contact, cannot be reproduced. Hence, it may be infer-

These facts appear to me to justify a surmise, that the ethereo-ponderable atoms of iron, in becoming magnetized and demagnetized, co-operate with the ethereo-ponderable atoms of the copper coils in the induction of secondary undulations. It is conceived that these may be owing to the intestinal change, attended by sound, as above stated; (73;) this being caused by a sudden approximation of the poles of the atoms, previously moved apart by the influence of the galvanized coil. But if this sudden coming together of the previously separated poles of atoms within a magnetized cylinder of iron, can contribute to the energy of secondary waves, it is consistent to infer that these waves owe their origin to an analogous approximation of the separated poles of the cupreous atoms, forming the finer coil in which the secondary undulations may be created, without the presence of iron. Of course this reasoning will apply to all cases in which the phenomena hitherto attributed to Faradian currents are the result of dynamic induction.

Thus it appears that the polarization of magnets, and that created and sustained when a galvanized coil or helix acts upon another in proximity, have the same relation to galvanic discharges that the charges upon insulated surfaces have to their appropriate discharges. The permanent magnetism of steel seems to have some analogy with the charge upon a coated pane, while we may consider as analogous with the charges upon insulated conductors, already adverted to, (61, 62,) that state of the ethereo-ponderable particles (38) of a wire helix, which *state*, resulting from the influence of an included magnet, or neighboring galvanized coil, and being discharged on a change of relative position, or breach of the galvanizing circuit, is productive of spark, shock, ignition, or electrolysis, as exemplified by Callan's coil, Page's electrotome, or the magneto-electric machine.

red, that the carbonaceous vapor is indispensable to this process, as a medium for the ethereo-ponderable polarizing waves, being soon consumed by the surrounding atmospheric oxygen. The excrescence upon the negative charcoal, observed by Silliman, together with the opposite appearance on the positive charcoal, may be owing to the lesser affinity for oxygen on the negative side.*

80. There may be some resemblance imagined between this luminous discharge between the poles, and that which has already been designated as diruptive ; (69 ;) but this flaming arch discharge does not break through the air, it only usurps its place gradually, and then sustains this usurpation. It differs from the other as to its cause, so far as galvanic reaction differs from friction : moreover, it requires a volatilizable, as well as a polarizable ponderable conducting substance to enable its appropriate undulations to meet at a mean distance from the solid polar terminations, whence they respectively proceed.

81. The most appropriate designation of the phenomenon under consideration, is that of ethereo-ponderable undulatory deflagration. Under this head, we may not only place the flaming arch, but likewise the active ignition and dissipation of fine wire or leaf metal, or when attached to one pole, and made barely to touch the other.

82. In one of Faraday's experiments, a circuit was completed by subjecting platina points, severally proceeding from the poles of a voltaic series, while very near to each other, to the flame of a spirit lamp. This was ascribed by him to the rarefaction of the air, but ought, as I think, to be attributed to the polarizable ethereo-ponderable matter of the flame, performing the same office as the volatilized carbon in the flaming arch, between charcoal points, to which reference has been made.

Summary.

From the facts and reasoning which have been above stated, it is presumed that the following deductions may be considered as highly probable, if not altogether susceptible of demonstration.

The theories of Franklin, Dufay, and Ampere, are irreconcilable with the premises on which they are founded, and with facts on all sides admitted.

A charge of frictional electricity, or that species of electric excitement which is produced by friction, is not due to any accumulation, nor to any deficiency either of one or of two fluids, but to the opposite polarities induced in imponderable ethereal matter existing throughout space however otherwise void, and likewise condensed more or less within ponderable bodies, so as to enter into combination with their particles, forming atoms which may be designated as ethereo-ponderable.

Frictional charges of electricity seek the surfaces of bodies to which they may be imparted, without sensibly affecting the ethereo-ponderable matter of which they consist.

When surfaces thus oppositely charged, or, in other words, having

* American Journal of Science, Vol. X. p. 121. 1826.

about them oppositely polarized ethereal atmospheres, are made to communicate, no current takes place, nor any transfer of the polarized matter: yet any conductor touching both atmospheres, furnishes a channel through which the opposite polarities are reciprocally neutralized by being communicated wave-like to an intermediate point.

Galvano-electric discharges are likewise effected by waves of opposite polarization, without any flow of matter meriting to be called a current.

But such waves are not propagated superficially through the purely ethereal medium; they occur in masses formed both of the ethereal and ponderable matter. If the generation of frictional electricity, sufficient to influence the gold leaf electrometer, indicate that there are some purely ethereal waves caused by the galvano-electric reaction, such waves arise from the inductive influence of those created in the ethereo-ponderable matter.

When the intensity of a frictional discharge is increased beyond a certain point, the wire remaining the same, its powers become enfeebled or destroyed by ignition, and ultimately deflagration: if the diameter of the wire be increased, the surface, proportionally augmented, enables more of the ethereal waves to pass superficially, producing proportionally less ethereo-ponderable undulation.

Magnetism, when stationary, as in magnetic needles and other permanent magnets, appears to be owing to an enduring polarization of the ethereo-ponderable atoms, like that transiently produced by a galvanic discharge. (Note page 188, and paragraph 68.)

The magnetism transiently exhibited by a galvanized wire, is due to oppositely polarizing impulses, severally proceeding wave-like to an intermediate part of the circuit where reciprocal neutralization ensues.

When magnetism is produced by a frictional discharge operating upon a conducting wire, it must be deemed a secondary effect, arising from the polarizing influence of the ethereal waves upon the ethereo-ponderable atoms of the wire.

Such waves pass superficially in preference; but when the wire is comparatively small, the reaction between the waves and ethereo-ponderable atoms becomes sufficiently powerful to polarize them, and thus render them competent, for an extremely minute period of time, to produce all the affections of a galvano-electric current, whether of ignition, of electrolysis, or magnetization. Thus, as the ethereo-ponderable waves produce such as are purely ethereal, so purely ethereal waves may produce such as are ethereo-ponderable.

The polarization of air upon electrified scalps is supposed to be due to a superficial association with the surrounding polarized ethereal atoms, while that of iron filings, by a magnet or galvanized wire, is conceived to arise from the influence of polarized ethereo-ponderable atoms, consisting of ethereal and ponderable matter in a state of combination.

Farradian discharges are as truly the effects of static ethereo-ponderable polarization, as those from an electrified conductor, or coated sur-

faces of glass are due to static ethereal polarization; (39, 40, 41;) last paragraph, note, page 274.

It is well known that if a rod of iron be included in a coil of coated copper wire, on making the coil the medium of a voltaic discharge, the wire is magnetized. Agreeably to a communication from Joule, in the L. and E. Phil. Mag. and Jour. for Feb. 1847, the bar is at the same time lengthened, without any augmentation of bulk; so that its other dimensions must be lessened in proportion to the elongation.

All these facts tend to prove that a change in the relative position of the constituent ethereo-ponderable atoms of iron, accompanies its magnetization, either as an immediate cause, or as a collateral effect.

Method of Welding Iron, Steel, and Sheet Iron.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

In an earthern vessel melt borax, and add to it one-tenth of sal-ammoniac. When these ingredients are properly fused and mixed, pour them out upon an iron plate, and let them cool. There is thus obtained a glassy matter, to which is to be added an equal quantity of quick lime.

The iron and steel which are to be soldered, are first heated to redness, then this compound, first reduced to powder, is laid upon them: the composition melts and runs like sealing wax; the pieces are then replaced in the fire, taking care to heat them at a temperature far below that usually employed in welding: they are then withdrawn and hammered, and the surfaces will be found to be thus perfectly united. The author asserts that this process, which may be applied to welding sheet-iron tubes never fails.

Rec. de la Soc. Polytech. Feb., 1847, p. 135.

New Use of Waste Steam.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

A manufacturer who has a steam engine which discharges much waste steam, conceived the idea of using it to raise pine apples. The steam was introduced under the root of the plants, and the heat and moisture united, acted so powerfully, that the pine-apples soon ripened; while the body of the plant being exposed all day to the open air, assumes a healthy and agreeable taste, which renders the fruit far superior to those which have been ripened in hot houses.

Ibid. p. 139.

Method of Bringing Out Sculpture upon Alabaster.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

This process is founded upon the property which alabaster or sulphate of lime nas, of being slowly eaten out by cold water, so that its polish is destroyed.

In the first place the sculptures in relief, and all the parts intended

to be preserved, are covered with a varnish insoluble in water, composed of wax dissolved in oil of turpentine, mixed with white lead, or rather with a turpentine varnish, to which white lead and a little animal oil has been added to prevent the varnish from hardening and adhering too strongly to the alabaster. This is applied with a soft paint brush, moistened with oil of turpentine, into which it must be dipped every time that varnish is taken. The reserved parts being thus covered, suffer the vessel or ornament to dry for some hours, and then place it in a vessel filled with cold water, and leave it there for 48 hours, or longer if it is thought necessary. The varnish is then removed with a fine sponge dipped in the oil of turpentine, and the vessel dried with a soft and very dry rag. When the vessel is thus cleared of its varnish, and dried, pass over it a new soft brush, first dipped in finely powdered plaster. This powder fills the pores of the plaster which has been attacked by the water, and renders it mat; which brings out the transparent parts of the alabaster in relief.

To clean ornaments and sculptures in alabaster: wash out any grease spots with oil of turpentine; then put the piece in water, and suffer it to remain until it is freed from its impurities. When you take it out, rub it with a very dry paint brush; let it dry, and pass over it powdered plaster. In this way the piece will be perfectly washed, and will look as though it had just come from the hand of the carver. Ibid, p. 140.

Account of the Experiments to determine the Principal Laws and Numerical Data, which enter into the Calculation of Steam Engines, by M. V. Regnault.

(Continued from page 211.)

For the fourth series of experiments a form of apparatus was devised similar in principle to that just described, but free from its objections. This consisted essentially of a glass globe, of a capacity of from 800 to 2000 cubic centimetres, to which was added a capillary stem about 20 centimetres long. The globe was placed in an appropriate metallic vessel, so that it could be alternately heated to 100°, and cooled to 0°; the tube passing out of a lateral opening terminated in a small copper pipe which had two other openings—one of these was for the moment closed, the other communicated with the apparatus for drying the air, by whose means the globe and tube were filled with dry air with the usual precautions. Another glass tube of 16 or 17 millimetres internal diameter was cemented at its lower end into an iron cap terminated below by a stop-cock, and carrying a lateral branch bent parallel to the axis of the tube; into this lateral branch was cemented a second tube, which was for a certain distance of the same diameter as the first, and terminated above by a capillary tube, a part of that which formed the neck of the globe, which was bent at right angles. This system of tubes being firmly and carefully adjusted in a vertical position, the second tube with its attached capillary branch was carefully dried and filled with boiled mercury, and the upper part of the capillary

tube, which was of course horizontal, was then fitted into the third opening of the small copper tube, so as to be in immediate communication with the neck of the globe. When firmly fixed, the stop-cock at the bottom of the compound tube was opened, and the mercury flowing slowly out was replaced by air drawn through the drying apparatus, and the apparatus filled with air to a certain mark, a, placed upon the vertical tube, where it was of greatest diameter, the glass globe being all the time immersed in boiling water: the drying apparatus was then removed, and the branch of the copper tube with which it communicated hermetically sealed, and the height of the barometer noted. The hot water was then discharged from around the globe, and replaced first by cold water and afterwards by pounded ice, the level of the mercury being kept at a, by suffering it to flow off when necessary by the stop-cock. When the globe has certainly reached the temperature of the ice, the barometer is read, and the difference of the heights of the mercury in the two communicating vertical tubes is measured. We have thus all the data for calculating the coefficient of dilatation of the air, but another observation may be had by reversing the experiment. To do this, re-connect the drying apparatus with the copper tube, the mercury will fall in the vertical tube in connexion with the globe, but must be kept at a by pouring mercury into the other vertical tube: when equilibrium has been attained, remove the drying apparatus, and close its branch of the copper tube, then replace the ice by boiling water, and repress the dilatation of the air by pouring more mercury into the vertical tube; when you are satisfied that the air has taken the temperature of boiling water, read the barometer, and measure the difference of the heights of the mercury in the two vertical tubes.

The mean of six experiments tried in this way gave 1·3665 for the coefficient of dilatation: the maximum result being 1·36710; the minimum 1·36580; difference $\frac{1}{105}$ of the mean.

By this method the dilatation of the air is determined under very different pressures; in fact, during the first period of every experiment, the air is under the atmospheric pressure 0·760 metre when at 100°, and only under the pressure of 0·550 metre when at 0°. In the second period, the air at 0°, is under the atmospheric pressure 0·760m., and when heated to 100° under the pressure of about 1·040m. It is even easy to arrange the apparatus so that the experiment may be tried under still greater differences of pressure. As the experiments showed no difference in the numbers obtained during these periods, (1.36655 during the first, and 1·36645 during the second period,) we must conclude that within these limits of pressure, the coefficient of dilatation of air is sensibly constant.

Fifth series of experiments. In all the experiments hitherto described, the dilatation of the gas was determined indirectly from a direct measurement of the augmentation of its elastic force when brought to a constant volume at a higher temperature, assuming the truth of the law of Mariotte. In order to get the dilatation directly, the gas enclosed in an eminently elastic envelope should dilate freely without changing

its elastic force, and the augmentation of volume must be carefully measured, the gas being all at the same temperature. It is difficult to see how these conditions can be realized in practice, but it may be done approximately by following the method adopted by M. Pouillet in his air pyrometer. (Traitè de Physique, 4me edit. tome 1, p. 255.) In this way the elastic force of the gas remains sensibly the same, but a very notable portion in the reservoir of dilatation is at a temperature but slightly differing from that of the surrounding air.

The apparatus used by M. Regnault was to a great extent similar to that just described, but the iron cap into which the two vertical tubes were cemented was differently adjusted. It had two stop-cocks by one of which the barometric tube could be made to communicate at pleasure with the exterior, while the other, which was placed under the tube in communication with the globe, was so bored that it might make a communication either between the two tubes or between this second vertical tube and the external air. These two tubes were placed in a glass vessel which could be filled with water so that they could be maintained at any and a uniform temperature. The experiment was conducted as follows: The globe being surrounded with ice, and the communication with the drying apparatus opened, the level of the mercury was brought to the mark α on the vertical tube; the communication between the two tubes being open, the mercury would of course be at the same height in both tubes; the communication with the drying apparatus was closed, the barometer and the temperature of the water around the tubes noted. The globe was then brought to 100°, the mercury in the vertical tube was of course depressed, and in order to keep that in the barometric tube, at about the same level with it, its stop-cock had to be opened and the mercury suffered to flow out; the two columns were thus kept nearly at the same height, that in the tube in which the air was dilating, being brought to a second mark β, and the exact difference in the heights of the two columns was carefully noted, as well as the height of the barometer, and the temperature of the water in the surrounding vessel. In order from this experiment to determine the dilatation of the air, it is only necessary to know the capacity of the globe, and of its stem as far as the mark α, and that of the vertical tube between α and β; these are all easily determined by the weight of pure mercury necessary to fill them.

Four experiments tried in this way gave a mean dilatation of 1·36706. The maximum being 1·36718; the minimum 1·36693; difference $\frac{1}{5468}$ of the mean. The coefficient of dilatation given by this fifth method is sensibly greater than that got from the others. This circumstance is not accidental, as in the second part of the memoir, similar differences are shown for other gases, and in certain cases these differences are very considerable.*

* M. Regnault describes in a note an independent series of experiments tried by him according to the method of M. Gay Lussac—that is, by observing the dilatations of a quantity of dry air contained in a true thermometer and separated from the external atmosphere by a small index of mercury. (Biot, Traitè de Phys. tom. 1, p. 182.) The results obtained did not agree at all, and were all feebler than by any of the other methods; the highest result recorded was 1·3647.

M. Regnault then proceeds to the discussion of his formulae, for the purpose of determining the probable error in his results, and he shows that in the first three series—principally owing to the uncertainty of the readings of the barometer within $\frac{1}{10}$ millimetre, the maximum probable error is about $\frac{1}{1000}$, which is about the greatest difference between the maximum and minimum results in any one series. The two last series include the same source of error, and another arising from the uncertainty of the temperature of the air in the capillary tube, which, however, he believes may be altogether neglected in his experiments, the apparatus having been carefully arranged so as to make this a very small fraction of the whole volume of air under experiment.

He finally assumes 0·003665 as the mean coefficient of dilatation of dry atmospheric air as determined by the first four series of experiments, and remarks that the number 0·00367 given by the fifth series must be adopted in experiments where the gas dilates freely and preserves its original elastic force. He also gives as a fraction easily recollected, the remark of M. Babinet than 0·00366666 would be expressed by $\frac{11}{30}$.

PART SECOND.

On the Dilatation of some other Gases under Pressures near that of the Atmosphere.

Physical philosophers admitted that all gases had the same coefficient of dilatation, but since so serious an error in the numerical value of this coefficient had been shown, it was necessary to submit this law also to verification, the result of which was to show its incorrectness. The experiments were tried chiefly by the method I and IV under constant volumes, and V under constant pressure. It is not necessary to describe them in detail, as M. Regnault has done, nor to give the methods by which the gases were purified, suffice it to say that all necessary precautions were taken, and the general results were as follows:—

	Coefficient of Dilatation from 0° to 100°.	
	Under constant volume.	Under constant pressure.
Hydrogen,	0·3667	0·3661
Atmospheric Air,	0·3665	0·3670
Nitrogen,	0·3668	"
Oxide of Carbon,	0·3667	0·3669
Carbonic Acid,	0·3688	0·3710
Nitrous Oxide,	0·3676	0 3719
Sulphurous Acid,	0·3845	0·3903
Cyanogen,	0·3829	0·3877

He also describes an apparatus, an easily imagined modification of method IV, by which the difference in the coefficient of dilatation of any two gases may be at once shown.

PART THIRD.

On the Dilatation of Gases under Different Pressures.

It has been generally admitted that the dilatation of gases is constant between the same limits of temperature, no matter to what pres-

sure they may be submitted; consequently, that it is altogether independent of their initial density. But it is difficult to cite conclusive experiments upon which this law is founded. Several observers having obtained the same value for the coefficient of dilatation of air, under different barometric pressures, concluded that the coefficient of dilatation of gases was constant under all pressures: but the barometric variations in any place are not sufficiently extensive to permit so general a conclusion to be thus deduced.

Sir Humphrey Davy is the only philosopher who has studied the dilatation of gases under very different pressures. (Phil. Trans. 1823, vol. ii, p. 204.

He states that he found the same dilatation for air taken with the densities $\frac{1}{6}$, $\frac{1}{3}$, $\frac{1}{2}$, 1, and 2; but his experiments were not made by a sufficiently delicate method to allow his results to be considered exact.

The experiments of M. Regnault upon this subject were tried with apparatus of the same character as those before described, as methods IV and V, with such modifications as the peculiar circumstances of the experiments rendered necessary: and the conclusion at which he arrived was that "*the air dilates, within the same limits of temperature, by quantities which are greater in proportion as the density of the gas is greater: that is, in proportion as its molecules are brought nearer to each other.*"

The following tables exhibit the results of his experiments upon air, carbonic acid, and sulphurous acid:

Dilatation of Gases under different Pressures, determined by the method of Constant Volumes. (II and IV.)

Atmospheric Air.

Pressure at 0°. Millimetres.	Pressure at 100°. Millimetres.	Density of the air at 0°, that of air at 0°, under a pressure of 760 millimetres = 1.	Volume of the air at 100°, that at 0° = 1.
109·72	149·31	0·1444	1·36482
174·36	237·17	0·2294	1·36513
266·06	395·07	0·3501	1·36542
374·67	510·35	0·4930	1·36587
375·23	510·97	0·4937	1·36572
760·00		1·0000	1·36650
1678·40	2286·09	2·2084	1·36760
1692·53	2306·23	2·2270	1·36800
2144·18	2924·04	2·8213	1·36894
3655·56	4992·09	4·8100	1·37091

Carbonic Acid.

758·47	1034·54	1·0000	1·36856
901·09	1230·37	1·1879	1·36943
1742·73	2387·72	2·2976	1·37523
3589·07	4759·03	4·7318	1·38598

Dilatation of Gases under different Pressures, determined by the method of Constant Pressures. (V.)

Atmospheric Air.		Carbonic Acid.		Hydrogen.		Sulphurous Acid.		
Pressure Milli.	Volume at 100°.	Pressure Milli.	Volume at 100°.	Pressure Milli.	Volume at 100°.	Pressure at 0°.	Pressure at 100°	Volume at 100°.
760	1·36706	760	1.37099	760	1·36613	760·00	760·00	1·39020
2525	1·36944	2520	1·38455	2545	1·36616	982·73	987·64	1·39804
2620	1·36964							

The general conclusions of this memoir are as follows:

1st. The coefficient of dilatation of air, 0·375, heretofore admitted by philosophers from the experiments of M. Gay Lussac, is much too great for dry air under the ordinary atmospheric pressure.

The coefficient 0·3645, which is the mean of the experiments published by M. Rudberg, is too small.

When the coefficient of dilatation of air is deduced by calculation, from the changes of elastic force which the same volume of gas undergoes when carried from 0° to 100°, its value is 0·3665.

But when this coefficient is deduced from the changes of volume of the same mass of gas in passing from 0° to 100°, its elastic force remaining constant, we find a value rather higher: that is—0·3670.

2nd. The coefficients of dilatation of the different gases are not equal, as has been hitherto admitted; they present on the contrary, notable differences, as may be seen by the numbers before cited.

There is often obtained for the same gas, very different values for its coefficient of dilatation, according as this is deduced immediately from the observation of the change of volume which the same mass of gas undergoes between 0° and 100°, its elastic force remaining the same, or calculated from the variation in the elastic force of the gas between 0° and 100°, its volume remaining constant.

3rd. The air and all other gases, except hydrogen, have greater coefficients of dilatation in proportion as their density increases.

4th. The coefficients of dilatation of the different gases approach nearer equality, as their pressures are lighter; so that the law which is thus expressed, "*all gases have the same coefficient of dilatation*," may be considered as a limiting law which is applicable to gases in a state of extreme dilatation; but which is farther from the truth in proportion as the gases are more compressed, or, in other words, as their molecules are brought nearer together.

(To be Continued.)

New Arrangement for Gas Burners, by M. Maccaud.

We find in the Bulletin of the Society for the Encouragement of National Industry, for February, 1847, a report by M. Payen, from a committee of the society, appointed to examine a new arrangement of gas burner, invented and submitted to the society by M. Maccaud, of Lyons.

The modification consists in an envelope of wire gauze, through which the air which is to support the combustion passes. This envelope produces two useful effects: the heat acquired by the wire gauze is transmitted to the air, and augments the light of the lamp; and at the same time the flame becomes more regular. The lamp submitted by M. Maccaud was an argand gas burner of twenty tubes; the gallery which supports the glass chimney is fitted with a wire gauze which surrounds the base of the chimney, and is prolonged downwards in a funnel form to the bottom of the burner. It was compared with another similar argand burner without the wire gauze, each giving a light equal to that of a Carcel lamp, burning 1½ oz. of oil per hour—where it was found that the expense per hour of the Maccaud burner was to that of the other lamp as 110 to 123, or as 100 to 111·8.

Fig. 1.

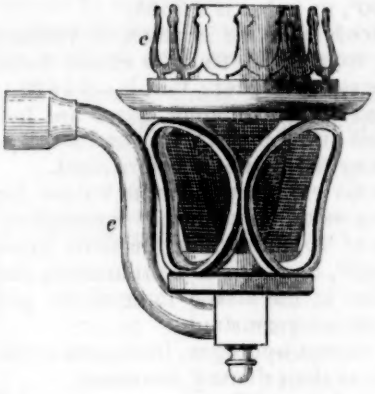


Fig. 2.

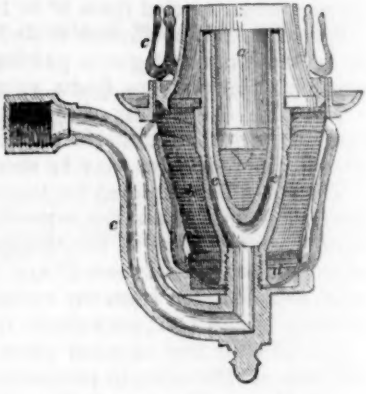


Fig. 3.

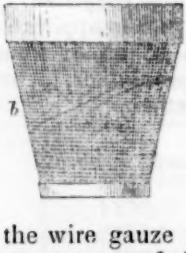


Fig. 4.

The use of the wire gauze renders the flame steady even when exposed to strong currents of air, so that when a window or door was suddenly opened, the flame remained unaffected, while that of the common lamp became red and smoky.

The committee also examined the behavior of these lamps as contrasted with that of ordinary gas burners in the open air, and especially in doorways and staircases, where the lamps were constantly exposed to draughts, and found that the flame of the Maccaud lamp was always unaffected, while that of the ordinary lamp was so much affected that the glass chimneys were constantly broken by the sudden deviations caused by the currents of air.

In certain particular cases, and where the lamps are to be constantly exposed to very strong currents of air, M. Maccaud covers the upper part of the glass chimney with a conical cap of wire gauze, which prevents the wind from driving the flame downwards; the wire gauze which he uses contains from 40 to 80 wires to the inch.

The invention above described is so simple that it seems incredible that it should never have been invented before. The high authority of the society from which the report emanates, as well as the known personal reputation of the reporter of the committee, are sufficient guarantees for the accuracy of the facts. As to the utility of it, it is unnecessary that we should dwell upon it in this climate where our houses are all open on summer nights, and not unfrequently the wind blows with such violence as to render it impossible to keep a common gas-light burning. When furnished with the cap, it will also prevent insects from accumulating upon the burner. The principle is also manifestly applicable to our street lamps, and would much benefit them in stormy nights.

Bull. Soc. Enc. Ind. Nat.

An Improved Manometer. *By* M. Galy Cazalat.

"In the manometer, of which the use is prescribed (in France) by the ordinance of May 22nd, 1843, the glass tube must exceed in height as many times 76 centimetres (30 inches), as the pressure of the steam exceeds an atmosphere.

"In order to shorten the column of mercury, the weight of which balances the force, it has occurred to me to oppose to the pressure of the steam the horizontal end of the rod of a piston, moving without friction, and steam-tight, which, by descending, causes the mercury to rise in the glass tube. According to this arrangement, if the area of the end pressed by the steam be n times smaller than that of the piston pressed by the mercury, this latter will rise in the tube to a height n times less than in the usual manometer."

It will be evident that the only practical difficulty to be overcome in this arrangement, is to render this piston *steam-tight*, at the same time that it shall move without friction. This object is attained, however, by the use of diaphragms elastic and impermeable interposed between the ends of the piston, and the mercury or steam.

With these remarks, a glance at the accompanying sketch, with reference to the explanations, will render further description unnecessary.

The moving principle is the brass piston c, on which impinges, and which transmits to the mercury, the pressure which the steam exercises

on the horizontal end of its rod *d*. For this purpose, the piston rod moves without friction in a central bushing of copper *e*, attached in

Fig. 1.

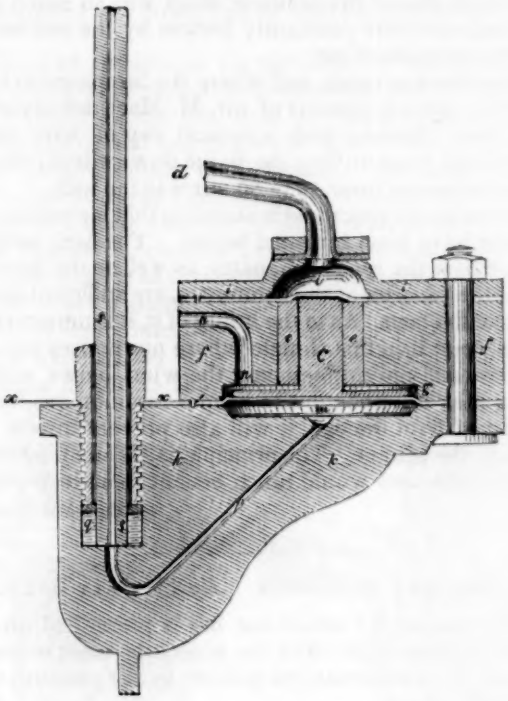
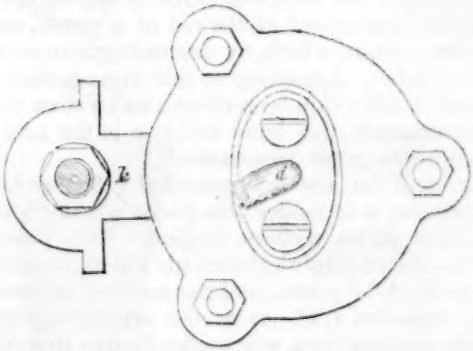


Fig. 2.



an iron cylinder *f*, of which the lower face is recessed at *g*, to receive the disc or piston *c*. The two ends of this cylinder are each covered with a flexible and impermeable membrane (as, for example, caout-

chouc) *v*, *v*. These two membranes are confined by the flanch *i*, *i*, and the base *k*, *k*, which form the cavities *l*, *m*; the upper one is full of water which communicates with the steam from the boiler by the tube *d*; while the lower is full of mercury by the canal *p*, with a vertical cylindric reservoir *q*, in which is attached the gauge tube *s*; *n* is a canal to conduct air to or from the upper face of the piston *c*, at its upper end, the tube terminates in a bulb (not shown) to receive any mercury which may be blown out.

The space in height, occupied by this apparatus, is evidently at the option of the maker; but for locomotives, 4 centimetres (1·57 inches) per atmosphere, is found to be a good scale; in which case, the relation of the two ends of the piston will be as 19 to 1; and for 7 atmospheres the whole height of the tube will be only 11·2 inches. Ibid.

Method of Closing Glass Vessels Hermetically.

M. Maissiot, of Paris, has proposed the following method of closing glass vessels of every size hermetically.

The mouth of the glass vessel is ground upon the top, and a glass plate ground so as to fit accurately upon it. A quantity of caoutchouc is then melted, (the addition of $\frac{1}{18}$ of its weight of tallow assists the melting and does not hurt the preparation,) the heat must be gentle and carefully regulated, and the matter must be constantly stirred; if the heat be raised too high it will be indicated by thick fumes. As soon as it is nearly fused, slacked and sifted lime is added, little by little, the paste being constantly stirred with a spatula. Immediately the strong smell of caoutchouc diminishes, and soon disappears entirely. It is then replaced by a peculiar odor which indicates that the operation has been well performed, and that the caoutchouc has combined intimately with a portion of the lime. The excess of this alkali plays the part of an inert powder, by which you may give the cement any consistence desirable. When it is as thick and tenacious as you want it, withdraw the vessel from the fire, and the cement is made. This cement possesses a remarkable plasticity, it appears scarcely to dry up; after a year's use, it does not appear to have in the least changed its properties. The property of hardening in time may be given to it by the addition of proper quantities of the compounds of lead. A thin coat of this cement is then spread with a knife over the edges of the vessel, and the cover being applied to it, pressed with the finger in the centre, and turned round for a moment, so as to spread the cement evenly, the joint will be found completely air-tight. The softness of the cement does not prevent it from adhering strongly to the glass. Thus, filling a cylindrical vessel of six inches in diameter, and immediately turning it upside down, the cover was not forced off, nor did the liquid leak.

M. Maissiot has enclosed in this way concentrated alcohol with a vacuum over it, which, after many months, remains perfect. This method will be found very advantageous for the preservation of preserves, fruits, and meats, by Appert's process, as well as for anatomical preparations, &c. Ibid.

Substitute for White Lead, &c.

M. Leclaire exhibited to the Academy, several specimens of painting, intended to show the advantages which colors with a zinc base possess over those whose base is lead or copper. The first, after being exposed to the action of sulphuretted hydrogen, preserved their lustre completely, while the others were all more or less altered.

The dangers to which the workmen who prepare them are exposed, or those even who employ only white lead, caused the white of zinc to be thought of long ago as a substitute; but besides the fact that there were no establishments in which this product was manufactured upon a large scale, and by an economical process, there remained another cause of unhealthiness in the necessity of employing oil prepared with litharge, as a drying oil, as well for the zinc as for the lead. M. Leclaire has got rid of this last cause of danger, by the discovery of a drying medium, whose base is manganese, the employment of which presents no inconvenience.

In painting houses, white lead is not the only poisonous material which is used; several other colors of lead and copper base are still generally employed. M. Leclaire has succeeded in replacing them by colors with zinc as the base, the use of which has not, up to the present time, appeared to injure the health of the workmen.

Comptes Rendus de l'Academie des Sciences, Jan. 24, 1848.

FRANKLIN INSTITUTE.

Monthly Meeting, March 16th, 1848. Mr. Oran Colton *presiding.*

The following donations were announced:

From Hon. Joseph R. Ingersoll, H. R.—

Message of the President of the United States to the two Houses of Congress, at the commencement of the first session of the 30th Congress. Washington, 1847.

From Hon. James D. Westcott, Jr., Sen—

Report of the Committee on Patents, (Senate.) No. 50.

From Col. S. H. Long, U. S. Top. Eng.—

The relative cost of Steam and Water Power; the Illinois Coal Field; and the advantages offered by the West, particularly on the lower Ohio, for Manufacturing. Louisville, Kentucky, 1848.

From the Massachusetts Charitable Mechanics' Association of Boston

Exhibition of the Massachusetts Charitable Mechanics' Association, at Faneuil and Quincey Halls, in the city of Boston, September, 1847. Boston, 1848.

From Hon. Thomas H. Forsyth, Esq., Senate, Pennsylvania—

Communication from the Auditor General, relative to the Banks and Savings Institutions of the Commonwealth. Harrisburg, 1848.

Tabular Statement relative to the State Tax on real and personal property, and to Common Schools. Harrisburg, 1848.

Senate file from No. 308.to No. 514.
House file from No. 404 to No. 522.

From Hon. Sol. W. Roberts, Esq.—
Communication from the Auditor General relative to the Banks and Savings Institutions of the Commonwealth. Harrisburg, 1848.
Tabular Statement relative to the State Tax on real and personal property, and to Common Schools. Harrisburg, 1848.
The Daily Legislative Record, to 14th March inclusive.

From Frederic Graff, Esq.—
Annual report of the Watering Committee for the year 1847, to the Select and Common Councils of the city of Philadelphia. Philadelphia, 1848.

From W. H. Dillingham, Esq.—
An Oration delivered before the Society of the Sons of New England of Philadelphia, December 15, 1847—the Anniversary of the Landing of the Pilgrims, by Wm. H. Dillingham, Philadelphia, 1847.

From Prof. James C. Booth—
The Encyclopedia of Chemistry, Theoretical and Practical, presenting a complete and extended view of the present state of Chemical Science, by James C. Booth, assisted by Campbell Morfit. Philadelphia—Carey & Hart.

From A. B. Hutton—
The Annual report of the Board of Directors of the Pennsylvania Institution for the Deaf and Dumb, for 1847. Philadelphia, 1848.

Anonymous—
An Examination of the legality of the General Orders which confer assimilated rank on officers of the Civil Branch of United States Navy. Philadelphia, 1848.

The Reports of Officers and Standing Committees were received.

A report was received from the committee on Mr. Elliot Cresson's proposition to found a medal, containing the following resolutions:

Resolved, That the corresponding secretary be directed to present the thanks of the Institute to Elliot Cresson, Esq., for the liberality and confidence manifested by him in placing at the disposal of the Institute, a fund for the perpetual award of a gold medal.

Resolved, That the President and Secretary be authorized to affix the seal of the Institute to the Deed of Trust, executed by Elliot Cresson, Esq., in relation to said medal, and the fund provided for the procuring thereof, in attestation of the acceptance of the same on the part of the Institute.

The resolutions on the report were adopted.

On motion of Mr. Weigand, the deed of trust was directed to be entered at large upon the minutes. The following is an abstract of its provisions:—

The Trust Deed assigns to Frederick Fraley and John Weigand, trustees, and their successors in the trust, one thousand dollars of the six per cent. convertible loan of the Schuylkill Navigation Company, reimbursable in 1866, subject to the following trusts:

I. Provides for keeping the principal as at present invested, until

paid off, then to reinvest in such funds as are designated by law for the investment of trust funds.

II. Suitable dies for the gold medal to be provided out of the first sufficient interest, and describes the devices and legends which shall be engraved upon the dies.

III. "After the said dies have been so prepared and paid for, out of the said money received for interest, the said parties of the second part, shall cause to be struck therefrom, from time to time, as the interest accruing on, and received from, the said sum of one thousand dollars will procure and pay for, such number of gold medals as the said interest will justify, and deliver the same to the Treasurer of the Franklin Institute of the State of Pennsylvania for the promotion of the Mechanic Arts, to be by him delivered to such persons or parties as the said Franklin Institute by any rule or regulation they may adopt, may have awarded the same. The said awards, however, in all instances to be made either for some discovery in the arts or sciences, or for the invention or improvement of some useful machine, or for some new process or combination of materials in manufactures, or for ingenuity, skill, or perfection in workmanship. And the said treasurer shall from time to time as he may receive any such medals, give receipts to the said second parties therefor, and whenever he may deliver any medal, he shall take duplicate receipts therefor from the party receiving the same, one of which receipts shall be delivered to the said second parties, and the other shall be filed in the archives of the said Franklin Institute, and annually, at the stated meeting of the said Franklin Institute, in the month of January, the said parties of the second part shall present to the said meeting, a statement of the accounts of their trust, showing the amount of the said principal sum, how the same is then invested, what interest or increase has been received therefrom during the preceding year, what amount has been expended and for what purposes, the number of medals delivered to the said treasurer, and the number thereof that he has delivered under the awards of the said Institute; which statement shall be filed among the archives of the said Institute."

IV. Provides, that in case of death or disqualification of either of the trustees, the other shall give notice to the Institute, who at their next stated meeting shall elect a successor.

Mr. G. W. Smith announced the death of Dr. Thomas P. Jones, the editor of the Journal, and after a brief notice of his life, it was, on motion, resolved that the President be requested to appoint a committee to draft a series of resolutions expressive of the regret of the Franklin Institute at the death of Dr. Jones.

The business of the meeting being concluded, Mr G. W. Smith exhibited and explained a model of Eckel's steam gauge; this consists of a small brass cylinder or tube placed outside of the boilers, and connected by tubes furnished with stopcocks, with the steam space in the boiler above, and with the water space below. These cocks being open, the water level in the gauge will be the same as in the boiler. When the water level is to be tried, the lower cock is stopped, by which the connexion with the water of the boiler is cut off,

and the water is then discharged by the pressure of the steam, from the gauge through another stopcock into a graduated vessel, and the height at which it stood in the tube, thus determined.

Mr. Heckerote was introduced to the meeting, and exhibited and explained a self-acting, attaching, and detaching car coupling, invented by him. This apparatus consists of a flat box with an opening in one side, into which the coupling bar passes, the sides of this opening flare outwards in curved directions, so that in whatever direction the bar is presented, it will be guided into the opening. The bar is made with a head, which, in entering, passes between a revolving cylinder or friction roller, and a tumbler, which it causes to rotate until it is caught by a trigger, pressed against it by a spring. The head of the coupling bar is then securely fixed, and cannot be disengaged without a backward rotation of the tumbler, which is prevented by the trigger. The peculiar arrangement will allow the bar to take any angle without diminishing the security of its hold. The trigger by which it is secured projects outwards, and is so arranged that if the cars take a very oblique position in reference to each other, (as if one should run off the track,) the trigger lever will be struck by the car, and the two cars will be detached from each other; each car has one of these coupling boxes, and the triggers project on different sides of the axis of the car, so that it cannot move off on either side without detaching the cars. Mr. H. stated that he had tried this invention practically by causing the front one of two cars thus connected to run upon a side track, while by suddenly reversing the switch, the hinder car was forced upon the main track, the cars were instantly detached from each other. With this coupling there is no danger of mutilation in connecting and disconnecting cars, and far less liability to accident in the event of the running the engine off the track, or of the breaking of an axle of a car.

Mr. J. B. Reynolds explained a model of a new method of producing a rotary motion for grindstones, &c., invented by Dr. Winslow, of this city. The stone is supported exteriorly upon an ordinary bearing, but upon the inner side the axis terminates in a hollow cylinder or cup, into which the extremity of the axle of the apparatus fits, upon the end of this axle is fitted a strong wooden tooth movable upon a centre so placed that while the axle rotates in one direction it presses upon the inside of the cup, and thus causes the stone to rotate with the axle; but when the axle moves in the opposite direction, the tooth moves back upon its centre, and no longer presses upon the cup, the stone then does not partake in the motion of the axle. Around the axle is wrapped a cord terminating in a loop to be turned by the foot, and when the motion of the foot ceases the axle is brought back by another cord wrapped around it in the opposite direction, and connected with a strong spring. Thus, when the foot presses downward, the axle rotates, and the tooth pressing upon the cup-shaped bearing of the stone, gives it a rotary motion; but when the motion of the foot ceases, and the axle moves back, the tooth is disengaged from the bearing of the stone which is left free to continue its rotation; the reapplication of the foot then operates to give it motion again, and thus a much higher velocity can be obtained than by the ordinary treadle.

Correction of an Error in our Report of Mr. Pantoleon's remarks on the sounds of all languages given in our March No., page 219.

"There are in all languages fifty-four articulations practically regarded as simple, eight tonic inflections, and twenty-one blended sounds —forming Comstock's universal alphabet of eighty-three letters—the only one in which tones are represented, which are so necessary in distinguishing words having the same articulation, such as *miner, minor, rite, wright, right, write, ail, ale, &c.* A strictly analytic alphabet would contain only twelve symbols; but these minute divisions of sound could not be applied to practice any more than quarter-tones in musical notation."

Baltimore Exhibition of American Manufactures.

We see by a printed circular which has been laid upon our table, that an endeavor is about to be made to get up an Exhibition of American Manufactures in Baltimore. The circular comes at so late an hour, that we can but allude to it, and ask for it the attention of our readers; and we hope that every citizen of our country will contribute what lies in his power, to the success of so deserving an endeavor, and to the progress of the system of public exhibitions of American Manufactures, which has done so much already for the arts of America.

The exhibition is to commence on the 17th of May next, and continue two weeks; the rooms will be opened for the reception of goods, from the 11th of May until the 17th.

All communications upon the subject must be addressed to B. S. Benson, Superintendent. Baltimore, Maryland.

It is our painful duty to announce to our readers the death of Dr. Thomas P. Jones, whose name has been for so long a time familiar to them as Editor of this Journal. Dr. Jones died at Washington, on the 11th instant, in the 75th year of his age.

This event having occurred while the Journal is going through the press, we cannot dwell upon it more at length, at present, but will take the opportunity in a future number, of doing justice to the memory of one, who has deserved so well of all friends of the mechanic arts.

ENGLISH AND FOREIGN

MINING GLOSSARY.

To which is added, the Smelting Terms used in France, Spain, and Germany.

From the London Mining Journal, and Railway and Commercial Gazette.

CORNWALL MINING TERMS.

Acicular—Slender, straight, crystals.

Adit level—A horizontal excavation, through which the water drawn from the bottoms of the mine thereto by the engine, and that from above, passes off to the surface. This level is usually commenced from the bottom of the deepest neighboring vale, and extended throughout a great part of the mine.

Adventurers—Those who have shares in a mine. According to Pryce, in his *Mineralogia Cornubiensis*, *In*-adventurers are shareholders who attend to the working, and supply goods, out of which they benefit themselves. *Out*-adventurers are those who pay their *quota* of the expenses, without attending to the management of the mine, or benefiting by any supplies.

Aggregated—When the component parts only adhere together, and may be separated by mechanical means.

Air-machine—An apparatus for forcing fresh air into, or withdrawing foul air from, badly-ventilated places.

Air-pipes—Tubes or pipes of iron or wood for ventilating underground, or for the conveyance of fresh air into levels having but one communication with the atmosphere, and, consequently, no current of air.

Ailch-piece—That part of a plunger lift in which the clacks are fixed.

Alliaceous—The garlic odor of arsenical minerals when heated or struck.

Amorphous—Without form.

Anhydrous—Without water of crystalisation.

Arch—A piece of ground left unworked near a shaft.

Arched—The roads in a mine, when built with stones or bricks, are generally arched level drifts.

Argillaceous—Consisting of clay.

Arborescent—Ramifying like a tree.

Arseniate—The arsenic acid united with a base, as copper in the arseniate of copper.

Attle—Rubbish, containing little or no ore.

Average produce—The quantity of fine copper contained in 100 parts of ore; thus, a parcel of ore, having a produce of 10*l*, contains 10*l* per cent. of copper, being rather above the average of copper ores in Cornwall.

Average standard—The price per ton of fine copper in the ore, after deducting returning charges for smelting, of 2*l*. 15s. per ton of ore in Cornwall, and 2*l*. 5s. per ton of ore at Swansea. The regulation of the standard depends entirely on the price which fine copper bears in the market, rising and falling in the same proportion. Supposing the produce of a parcel of ore to be 10, and the price at which it was sold to the smelter to be 8*l*. 18s., the standard of that parcel will be thus obtained:—10 tons of the ore will be required to yield 1 ton of fine copper—therefore, 8*l*. 18s. × 10 = 89*l*. will be the value of the ore containing a ton of metal. For the same reason, the returning charge of 2*l*. 15s. must be multiplied by 10, making 27*l*. 10s., which, added to the former sum of 89*l*., makes 116*l*. 10s. being the standard of that parcel. Low produce ore will naturally have a higher standard.

Axis of a crystal—The lateral planes surround its axis, which is an imaginary line passing down the middle of the prism from the centre of the upper to that of the lower terminal plane.

Back—The back of a lode is the part nearest the surface. The back of a level is that portion of the lode extending above it to within a small distance of the level next above.

Bal—The miner's term for a mine.

Batch of ores—Certain quantity of ore sent to the surface by any *pair* of men.

Bar of ground—A vein of a different description of rock, &c., from that in its vicinity.

Base—The substance to which an acid is united.

Bearers—Supports to the pumps in the engine-shaft.
Beat away—To excavate; usually applied to hard ground.
Bed—A seam, or horizontal vein of ore.
Bend—Indurated clay; a name given by miners to any indurated argillaceous substance.
Bit—The steeled end of a borer.
Black jack—Blende.
Blende—One of the ores of zinc, composed of iron, zinc, sulphur, silex, and water; on being scratched it emits a phosphoric light.
Black tin—Tin ore ready for smelting.
Blast holes—The holes through which the water enters the "windbore," or bottom of a pump.
Block tin—Metallic tin.
Blast—The air introduced into a furnace.
Blasting—Forcing off portions of rock by means of gunpowder. A hole is made with a borer, into which gunpowder is inserted, then confined, and set fire to.
Blower—A smelter.
Bounds—The proprietary of tin ore over a given tract.
Bob—The engine beam.
Bowlders—Large stones or pebbles.
Botryoidal—Globular forms, such as are found in copper, &c.
Borer—A boring instrument, with a piece of steel at the end, called a boring bit.
Brace—The mouth of a shaft.
Branch—A small vein which separates from the lode, and very generally again unites therewith.
Brood—Impurities mixed with the ores.
Bryle—The traces of the presence of a lode, found in the loose matter, on or near the surface.
Buckers—Bruisers of the ore.
Bucket—The piston of the lifting pump.
Bucket tift—A set of iron pipes attached to a lifting pump.
Bucket rods—Wood rods, to which the piston of a lifting pump is attached.
Bucking iron—The iron or tool with which the ore is pulverised.
Bucking plate—An iron plate on which the ore is placed for being bucked.
Buddling—Separating the ores from the earthy substance by means of an inclined hutch or cistern.
Bunch, or squat of ore—A quantity of ore of small extent; more than a stone, and not so much as a course.
Burden, or overburn—The substances reposing on a bed of stream tin ore.
Burning house—The furnace in which tin ores are calcined to sublime the sulphur from pyrites; the latter being thus decomposed, are more readily removed by washing.
Burrow—A heap of deads, attle, rubbish.
Cage of a whim—The barrel on which the rope is wound up.
Cal—Wolfram.
Cand or Kand—Fluor.
Capel—A stone composed of quartz, schorl, and hornblende, usually occurring on one or both walls of a lode, and more frequently accompanying tin than copper ores.
Captain—One of the superintendents of the mine.
Captain dresser—Superintendent of the dressing of the ores.
Carrack—See *Capel*.
Cases of spar—Veins of quartz (not containing ores) which have not a direction parallel to the lodes.
Casing—A division of wood planks, separating a foot way, or a whim, or engine-shaft, from one another.
Cathead—A smaller capstan.
Caunter lode—A lode which inclines at a considerable angle with the direction of the other lodes in its vicinity.
Charger—An implement in the form of the bit of a carpenter's auger, for charging holes for blasting, which are dug horizontally.
Chimming—A process of similar effect to tossing, but being performed on small quantities of ore, the keeve is supported on the verge of its bottom.
Clack—The valve of a pump of any description.
Clack door—The aperture through which the clack of a pump is fixed and removed.
Claying—Lining the hole (in which gunpowder is to be placed) with clay, to prevent the powder becoming damp.

Cob—To break the ores with hammers in such a manner as to separate the dead or worthless parts.
Cockle—Schorl.
Coffin—Old workings open to the day.
Cost Book—Cornish mines carried on upon the cost-book system, as was described in an article on "Mining and Railway Liabilities" in the *Mining Journal*, do not come under the effect of the New Joint-Stock Registration Act, but are regulated by the stannary laws of Cornwall. The plan is to insert in the "cost book" the name and address of each of the adventurers who first commence working the mine, all subsequent transfers of shares, and every expense attached to the undertaking; a meeting is held every two months, when the purser presents his accounts, made up for that period, and, consequently, the shareholders are enabled to judge of the profitable nature or otherwise of the undertaking, before any extensive liabilities are incurred; and any one feeling dissatisfied may, on paying his proportion of the debts due, "sign his name off the cost-book" as it is termed, and by which he ceases to be liable for any future costs.
Country—The strata or rock through which the vein or lode traverses.
Course of ore—A portion of the lode containing a regular vein of ore.
Cover—The box into which the ore is removed from the rock; also the place at the head of the trunk, in which the slimes are by agitation mechanically suspended in water, in the process of trunking.
Crib, or Curb—A circular frame of wood, screwed together, as a foundation for bucking or pulverising ore in a shaft.
Creases—Divisions of buddled work.
Cross-course—A lode or vein which intersects or crosses a lode at various angles, and generally throws the lode out of its regular course.
Cross-course spar—Radiated quartz.
Cross-cut—A level driven at right angles to the direction of the lode.
Crop—The best ore.
Crushing—Grinding the ores without water.
Cuneiform—Wedge shaped.
Cube—A solid figure, contained under six equal squares.
Cupelo—A small furnace.
Cut—To intersect by driving, sinking, or rising.
Costeaning—Discovering lodes by sinking pits in their vicinity, and driving transversely to their supposed direction.
Chats—Small heaps of ore.
Cofering—Securing the shaft from the influx of water by ramming in clay, &c.
Collar of a shaft—The timber by which its upper parts are kept from falling together.
Collar launder—The pipe or gutter at the top of a lift of pumps through which the water is conveyed to the cistern.
Connection or Connecting rods—The larger rods which are attached to the engine beam.
Core—Miners usually work but six hours at a time, and, consequently, four pairs of men are required for the whole time—"forenoon core," from 6 A. M. to noon—"afternoon core," from noon to 6 P. M.—"first core by night," from 6 P. M. to midnight—and "last core by night," from midnight to 6 A. M.
Dam—Choke damp, foul air.
Deads—Attle or rubbish.
Dead ground—A portion of the lode in which there is no ore.
Dean—The end of a level or cross-cut.
Dialling—Surveying for the purpose of planning.
Dileuing or Terluing—Washing ores supported on a hair-bottomed sieve in water.
Dippa—A small pit.
Dish—That portion of the produce of a mine which is paid to the landowner or lord.
Dissueing—Is when the lode is small and rich, to break down the strata from one of its walls, by which means it can afterwards be taken away without being deteriorated, and without waste.
Dowsing-rod—The hazel rod of divination, by which some pretend to discover lodes.
Dropper—A branch when it leaves the main lode.
Draft engine—An engine used for pumping.
Dredging ore—A stone impregnated, or traversed by minute veins of ore.
Driving—Digging horizontally.

Drift—The excavation made for a road under-ground.
Dressers—Cleaners of the ore.
Durns—A frame of timber with boards placed behind it, to keep open the ground in shafts, levels, &c.
Dzhu or hulk—To dig away a portion of the rock, &c., on one side of the end, that the blast may be more efficient.
Elvan—Porphyry, clay, stone.
End—The further extent of a level or cross-cut.
Engineer—The superintendent of the machinery.
Engine-man—Man who attends to, and works the engine.
Engine-shaft—The pit or shaft by which the water is drawn by the engine from the lower parts of the mine, to the adit or surface.
Fast—The firm rock beneath the diluvium.
Fang—A niche cut in the side of an adit, or shaft, to serve as an air course; sometimes a main of wood pipes is denominated a fanging.
Feeder—A branch when it falls into the lode.
Flang—A two-pointed pick.
Flat rods—Rods for communicating motion from the engine horizontally.
Floran tin—Tin ore scarcely perceptible in the stone; tin ore stamped very small. —(*Pryce.*)
Flookan—A soft clayey substance, which is generally found to accompany the cross-courses and slides, and occasionally the lodes themselves; but when applied to a vein, means a cross vein or course composed of clay.
Fluke—The head of the charger; an instrument used for cleansing the hole previously to blasting.
Footwall—Is the wall under the lode; it is sometimes also called the underlaying wall.
Footway—The ladders by which the workmen ascend and descend.
Forcepiece—A piece of timber put in a level, shaft, &c., in a diagonal position, for keeping the ground open.
Fork—"Water in fork," water all drawn out; the bottom of the engine-shaft.
Furnace—The place in which the ore is placed for the purpose of smelting or reduction.
Gad—A pointed wedge of a peculiar form, having its sides of a parabolic figure.
Glist—Mica.
Good levels—Levels driven nearly horizontal.
Gossan—Oxide of iron and quartz generally occurring in lodes at shallow depths.
Grass—The surface.
Grain tin—Crystaline tin ore; metallic tin smelted with charcoal.
Grate—Stamps grate; a metallic plate pierced with small holes; it is attached to the stamps, and through the holes the stamped ores escape.
Griddle or riddle—A sieve.
Grinder—Machinery for crushing the ores between iron cylinders or barrels.
Growan—Decomposed granite; but sometimes applied to the solid rock.
Ground—The country; the stratum in which the lode is found.
Gulph of ore—A very large deposit of ore in a lode.
Gunnies—Levels or workings.
Gurt—A gutter; a channel for water.
Halvanner—The dresser of, or operator on, the halvans.
Halvans—The ores which are not sufficiently rich to be offered for sale until much of the impurities with which they are mixed is removed by operations in water.
Hanging wall—The wall or side over the lode.
Hauling—Drawing ore or attle out of the mine.
Head sword—The water running through the adit.
Heave—The horizontal dislocation which occurs when one lode is intersected by another having a different direction. A right or left hand heave is when the part of the intersected lode on the opposite side of the traversing vein is found by turning either to the right or left.
Hook handles—The handles by which a windlass is worked.
Horse—The dead ground included between two branches of a lode, at the point of their separation.
House of water—A vugh or space, whether artificially excavated or not, filled with water.
Horse arm—The part of a horse whim to which the horses are attached.
H Piece—See *Aitch piece.*
Hutch—Cistern or box.
Irestone—Hard clay slate, hornblende, hornblende slate, hornstone.

Jigger—Cleaner of the ores.
Jigging—Separating the ore with a griddle or wire-bottomed sieve, the heavier substance passing through to the bottom or lower part of the sieve; the lighter substances remaining on the upper part are put by for halvans.
Junction—Applied to where veins unite.
Jumper—A long borer, worked by one person.
Keeve—A large vat.
Kibble—A bucket usually made of iron, in which the ores, &c., are drawn to the surface.
Kibble filler—Man who sends up work, &c., to the surface.
Killas—Clay slate.
Lander—Man who attends at mouth of shaft to receive the kibble in which ores, rubbish, &c., are brought to the surface.
Lappior—The dresser of the leavings.
Laths—The boards which are put behind and supported by the "durns."
Launders—Tubes or gutters for the conveyance of water; their form that of a long box, wanting the upper side and both ends.
Leader of the lode—A branch or small vein; part of the main lode.
Learies—Empty places; old workings or vughs.
Leat—A watercourse.—(*Pryce.*)
Leavings—The ores which are left after the "crop" is taken out.
Levels—Galleries driven on the lode usually at ten, twenty, thirty, &c., fathoms below the adit level.
Lifters—Wood beams, to which the iron heads of a stamping mill are fastened.
Lock piece—A piece of timber used in supporting the workings.
Lode—A regular vein producing or affording any kind of metal.
Loobs—Slime containing ore.
Lost levels—Levels which are not driven horizontally.
Machine whim—A rotary steam-engine employed for winding.
Mallet—An instrument used with the borer.
Material man—One who delivers out, and has care of the materials.
Meat earth—The vegetable mould.
Mock lead—Blende.
Moorstone—Granite.
Mundic—Iron pyrites.
Needle or Nail—A long taper piece of copper or iron with a copper point used when stamping the hole for blasting, to make, by its withdrawal, an aperture for the insertion of the rush or train.
Owner's account men—Workmen paid at so much per day.
Pack—To occasion the speedy subsidence of the ore in the process of tossing or chimming, by beating the keeve in which it is performed by a hammer.
Pair—Gang or party of men.
Parcel—A heap of ore dressed and ready for sale.
Pass—An opening left for letting down stuff to the level.
Peach—Chlorite.
Pedn cairn—A bunch of ore at a distance from the lode.
Pick—An instrument of common use, as well in agriculture as in mining.
Picker or Poker—A hand chisel for dzhuing, which is held in one hand, and struck with a hammer.
Pillar—A piece of ground left to support the roof or hanging wall.
Pitch—Limits of the piece of ground set to tributers.
Pitch bag—A bag covered with pitch, into which powder is put (previously to its being introduced into a damp hole) that it may be protected from moisture.
Pitman—One employed to look after the lifts of pumps and the drainage.
Pitwork—The pumps and other apparatus of the engine-shaft.
Plat—Ground taken away to contain any ores or deads.
Plunger—The piston or forcer of a forcing pump.
Plunger lift—The set of pipes attached to a forcing pump.
Point of the horse—The spot where the vein is divided into two or more branches.
Pol-roz—Pronounced polrose; the pit underneath a water wheel.
Pol-grown—Soft decomposed granite.
Prian—Soft white clay, esteemed a favorable sign when found in a lode.
Pril—A solid piece of virgin metal, or the button from an assay.
Produce—Fine copper contained in 100 parts of ore.
Purser—The cashier or paymaster at the mines.
Quere—A small cavity or fissure.
Rack—An inclined frame on which the ores and slime are washed and separated.

Racking—Is a process of separating small ore from the earthy particles by means of an inclined wood frame; the impurities being washed off, and the ore remaining near the head of the rack taken from thence, undergoes tossing.
Reed or spire—Gorse, or other tubular vegetable, into which gunpowder is put to convey a train from the snoff to the charge, the reed being put into the aperture made by the needle.
Refining—Separating the ores.
Relief—When one workman of the same pair changes core, or takes the place of another.
Riddle or griddle—A sieve.
Rising—Digging upwards.
Row—Large stones, rough.
Rullers—The persons who work the wheel barrows underground.
Run—When excavations fall together.
Run of a lode—Its direction.
Rush—Used for the same purposes as the reed and spire.
Scal—A shale or portion of earth, rock, &c., which separates and falls from the main body.
Scovan lode—A lode having no gossan on its back or near the surface.
Scraper—A piece of iron used to take out the pulverised matter which remains in the hole when bored, previously to blasting.
Seam—A horse load.
Set—A number of mines taken upon lease.
Set of timber—A frame complete to support each side of the vein, level, or shaft.
Set off—The part of a connecting rod to which the bucket rod is attached.
Shaft—A sinking or pit either on the lode or through the country.
Shaking—Washing the ores.
Shammel—When ore or water is lifted part of the required height by one machine or person, and part by another.
Shears—Two very high pieces of wood placed in a vertical position on each side of a shaft and united at the top, over which by means of a pulley passes the capstan rope. This is for the convenience of lifting out or lowering into the shaft, timber, or other things of great length.
Shelf—The firm rock.
Shieve—The pully over which the whim rope passes.
Shoding—Tracing round stones from the vale to the lode whence they were torn by the deluge, or by some convulsion of nature.
Shooting—Shutting or blasting; fracturing and separating by the use of gunpowder.
Sinking—Digging downwards.
Skimpings—Skimmings of the light ores, &c., in the dressing process.
Slide—A vein of clay which, intersecting a lode, occasions a vertical dislocation.
Slimes—Mud containing metallic ores; mud or earthy particles mixed with the ore.
Smelting—Reducing the ores by means of fire.
Snoff or match—A substance, frequently brown paper, or other slowly combustible substance, which is ignited at one end, the other being in contact with the rush or train in blasting; the slow combustion is to permit the escape of the laborers.
Sollar—A small platform at the end of a certain number of ladders.
Spalling—The breaking up into small pieces, for the sake of easily separating the ore from the rock, after which it undergoes the process of cobbing.
Span Beam—The horizontal beam passing over the whim in which the upper pivot of the perpendicular axis moves.
Stamps—Machinery for crushing the ores with the presence of water.
Stamp head—The iron weight or head connected with the stamps.
Standard—The price of fine copper.
Stannary laws—Regulations for the management, &c., of tinners, administered by equity judges resident in Cornwall and Devon.
Stem—A day's work.
Stope—A horizontal bed; *to stope*, to excavate horizontally, layer after layer.
Spar—Quartz.
Spewl—To break ground; to work away.
Spunt of ore—See *Bunch*.
Strake—A launder, or box of wood without ends, in which the process of washing or tying is performed.
Strapping plates—The iron plates by which the connection rods are fastened to each other.

Stream tin—Tin ore found in the form of pebbles, most frequently in vales.
Streamers—The persons who work in search of stream tin.
String—A small vein.
Stuff—Attle or rubbish.
Stull—Timber placed in the backs of levels, and covered with boards or small poles to support rubbish.
Sturt—When a tributer takes a pitch at a high tribute, and cuts a course of ore, he sometimes gets two, three, to five hundred pounds in two months; this great wages is called a sturt.
Sump—A pit; the bottom of the engine-shaft.
Sump-shaft—The engine-shaft.
Sumpmen—The pitman's assistants; men who attend to the machinery in the engine-shaft.
Tackle—Windlass, rope, and kibble.
Tamping—The material, usually soft stone, placed on the gunpowder, in order to confine its force, which would otherwise pass up the hole; also, the process of placing the material.
Tamping iron or bar—Tool used for beating down the earthy substance on the charge used in blasting.
Team—To lade water in bowls.
Thrown—either up or down—Is when a slide intersects a lode, the dislocation being shown by a transverse section—*Thrown up*, is when the undiscovered portion of the intersected lode is found to have been apparently lengthened—*Thrown down*, is the reverse.
Ticketings—The sale of ores.
Timber man—The man employed in placing supports of timber in the interior of the mine.
Tollar—A person who periodically examines the limits of ground producing tin ore belonging to himself or (the lord) his employer.
Ton—The ton varies in different districts: the common ton is 20 cwt. of 112 lbs. or 2,240 lbs. In Cornwall, the mining ton is 21 cwt. of 112 lbs. or 2,352 lbs. Tin is sold in Cornwall by the 1,000 lbs. and not by the ton.
Tossing or Tozing—A process consisting in suspending the ores by violent agitation in water, their subsidence being accelerated by packing—the lighter and worthless matter remaining uppermost.
Trade—Attle or rubbish.
Tram carriage—The carriage (usually made of iron) used on a tram-road.
Tram road—Iron railroad way.
Treloobing—See Tossing.
Tribute—Proportion of the ore which the work-man (tributer) has for his labor.
Tributers—Men whose pay is a certain proportion of the ore or value of the ores they raise.
Tribute pitches—The limited portions of a lode which are set to "a pair" of tributers, beyond which they are not for the time being permitted to work.
Tunnel head—The top of a furnace, at which the materials are put in.
Turned house—A term used when a level, in following branches of ore, is turned out of the original direction.
Trunk—A long narrow cistern or pit, in which the ore and slime which are mixed are separated by the subsidence of the former, and the washing off the impurities—the inclined box in which the ore and slimy impurities are separated in the process of trunking.
Trunking—Process of extracting ores from the slimes—subsequently the ores undergo the processes of racking and tossing.
Tummals—A great quantity; a heap.
Tut work—Work in which the laborer earns in proportion to the amount of his labor; being paid for driving at a certain price per fathom.
Tuyere—The aperture through which the air or blast is introduced into the furnace.
Tying—Washing.
Underlayer—A perpendicular shaft, sunk to cut the lode at any required depth.
Underlayshaft—Shaft sunk on the course of the lode.
Van—To wash and cleanse a small portion of ore on a shovel.
Vugh or vogle—A cavity.
Washing—The ore undergoes occasionally two or three washings; the first process being that of washing the slime and earthy particles from the rougher and large stones of ore.
Water in fork—When all the water is extracted.

Well—The lower part of a furnace into which the metal falls.
Whim—A machine worked by horse, steam, or water, for raising ores, &c.
Whim driver—Man who attends to the horse in the whim.
Whim rope or chain—The rope or chain by which the kibble is attached to the winding engine or whim.
Whim shaft—The shaft by which the stuff is drawn out of the mine by horse or steam whim.
Whip and derry—A kibble drawn to the surface by a horse, the rope attaching one to the other simply passing over a pulley.
Winch or winze—Contraction of windlass; the wheel and axle frequently used for drawing water, &c., in a kibble by a rope.
Windbore—The lowest pump in which there are holes to admit water.
Winding engine—One used to draw up ore, attle, &c.
Winze—A sinking on the lode communicating one level with another, for proving the lode, or for ventilating such drivings.
Work—Ores before they are cleansed or dressed.
Working barrel—The pump in which the piston works.
Working big—Sufficiently large for a man to work in.
Zawn—A cavern.
Zighyr—When a small slow stream of water issues through a cranny it is said to zighyr or sigger.—(*Pryce.*)

DERBYSHIRE MINING TERMS.

Adit—A horizontal level taken up at the foot of a hill, and either driven on the lode or to intersect it, for unwatering or draining the mine at that level, and also occasionally used for bringing out the ores. The top adit is the adit first driven, deep adit the lowest adit driven, air adit is the adit driven purposely for ventilating the mine.
Arched—The roads in a mine when built with stones or bricks are generally arched; level drifts and horse roads, either when cut in coal or in other strata, are formed arch fashion in the cutting for better security.
Bank or benk—The face of the (coal) works or place where the miners are turning out the coal, sometimes called benk face.
Bar master—An officer who superintends the lead mines.
Bar mote—A hall or court in which trials relative to lead mines are held.
Bassit—The outcrop of the strata, when a substance as coal appears at the surface it is said to bassit; also sometimes used to signify the upper end of the works, as the bassit or upper end.
Bearer or biard—A large piece of timber to support the cistern and pumps in an engine-shaft.
Balland—Dusty lead ore.
Belt—A strap to which is attached a chain, by which coal miners draw the loaded corves of coal.
Bender—A piece of iron attached to trunks or barrels to which the pit rope is affixed.
Bina—Indurate clay; a name given by miners to any indurate argillaceous substance.
Binghole—A hole through which the ore is thrown.
Bingplace—The place where the ore is laid ready for smelting and measuring.
Boring bit—A piece of steel placed at the end of the borer.
Blast—The air introduced into a furnace.
Blasting—A hole made with a borer in which gunpowder is introduced, which being confined, and set fire to by a match, forces off a portion of the rock or lode—the process is called blasting.
Board, or Board gate—An adit is driven board when it runs in a transverse direction to the grain or face of the coal.
Borer, Augur, or Drill—A round piece of iron, the one end steeled.
Bow—See Bender.
Bowse—Lead ore as cut from the vein.
Breast—The face of the (coal) workings.
Brettis (in coal mines)—A quantity of wood packed together, and the interstices filled up with slack or rubbish.
Brettis way (ditto)—A way or road in the mine supported by brettises, built up on each side after the coal has been wrought out.
Bucker—A flat piece of iron with a wooden handle used for breaking or crushing the ore by hand.

Bucklers, or Tacklers—Small chains put round the coals, when loaded in corves, to prevent them from falling off.
Buddle—A frame made of wood and filled with water in which the lead ore is washed.
Budling—Washing inferior ore lead to free it from extraneous matter.
Bule—A piece of wrought iron to put round buckets or clack doors on large pumps, to hold them in their respective places.
Bunding—Wood placed on which the refuse cuttings or deads are thrown.
Butty—In collieries a person who contracts to raise coal by weight or measure.
Cank—Whimstone.
Cap or Lid—A flat piece of wood placed between the top of the punch and the roof of the mine.
Cat dirt—A substance also called toadstone, being sometimes clay, coal, and pyrites of iron; at others, a kind of earthy scoria not unlike lava.
Chair—Used in drawing up ore or coal.
Chisel—See Drill.
Churndrill—A large drill from four to six feet long, commonly made with a chisel point at each end.
Cleet—A wedge.
Clivis—A hook with a spring to prevent its unfastening.
Coesteads—A small building.
Cofer—Cofering is beating a quantity of clay round the bricking in shaft to prevent the water coming through, and to hold it back in the strata.
Colliery bailiff—Superintendent of the colliery.
Cope—To agree to get lead ore at a fixed sum per dish or load, or other measure.
Coper—One who agrees to get lead ore by bargain.
Corf—A square frame of wood to load coals on; a kind of sledge used to carry ore from the miners at work to the shaft bottom.
Creep—The weight of the incumbent strata after the coal has been partially worked out.
Crib, or curb—A circular frame of wood, either pinned or screwed together, to serve as a foundation for the bricking in a shaft.
Cross-cuts—Are lodes or levels driven in a diametrical direction, across the range of the vein.
Crow-bar—A lever from six to eight feet long.
Cupelo—A small furnace, worked by blast.
Curb—See Crib.
Cutting—An air course set up at either end of the work after the coal has been wrought out.
Crosses and holes—When a person discovers a vein, and has no means to possess it for want of stowces, he marks the ground with crosses and holes, by which means he possesses it until he can procure stowces.
Dam—Dams are made for various purposes underground, either for holding back water or noxious vapors, such as choke or fire damp. They are generally built either with sand or clay.
Dan—A square frame of wood to draw coals from the work to the main roads underground.
Deads—Cuttings of stone of no use, attle or rubbish.
Deep level—The watercourse leading to the engine-shaft, being always the deepest adit in the mine.
Dial—A compass used to take bearings in mines.
Dialling—Taking the different bearings of the various ways, gates, &c., in a mine; surveying.
Dish—A measure containing fifteen pints Winchester measure.
Door in a mine—Is sometimes used to open and shut, to increase the circulation of air.
Dresser—See Loading pick.
Drift—The excavation made for a road underground.
Drill—An instrument for boring shot and other holes.
Driving—Cutting and blasting horizontally, applied to making a level or adit.
End—An adit is said to be driven end when it is in a line with the grain of the coal.
Ending—An adit driven in a direction with the grain of the coal.
Elve—The shaft or handle of a pick.
Face—The face of the coal is at right angles with the grain.
Fang—A niche cut in the side of an adit or shaft to serve as an air course; sometimes a main of wood pipes is denominated a fanging.
Fausted—Refuse lead ore requiring to be dressed finer.

Fault—An intersection of the strata.
Feigh—The refuse washed from the lead ore.
Flat—Flat work, &c., when a vein, &c., is horizontal.
Forks—Pieces of wood used to keep the side up in soft places.
Foundermere—The first thirty-two yards of ground worked.
Foundershaft—The first shaft that is sunk.
Forefield—The face or extent of the workings.
Forefield end—The farthest extremity of the workings.
Freeing—Entering a mine or vein in the bar-master's book.
Fuzze—Straws or hollow briars, reeds, &c., filled with powder.
Gallery—A drift or level.
Gate—Road or way underground; it has various uses, either for air, water, or for bringing out the mine, coal, &c.
Gin—The machine by which the coal or ore is raised from the mine.
Gobbing—The rubbish remaining after the coal has been extracted.
Grove—A mine.
Gingoni—Walling up a shaft instead of timbering to keep the loose earth from falling.
Hade—The underlay or inclination of the vein.
Hadings—When some parts of the vein incline and others are perpendicular.
Hangbench—Part of the stowees.
Hanging side—The wall or side over the vein, or to which it hangs.
Horn—A line running horn is at an angle of 45 deg. with the face of the coal.
Jackhead pit—A well sunk inside the mine for various purposes.
Jackhead pump—The house water pump of an engine is sometimes so called.
Jig pin—A pin used to stop the machine in drawing when necessary.
Judge—A staff to measure underground work with—viz. the holeing in coal work.
Jumper—A large borer, an iron instrument worked by hand, and steeled at each end like chisel bits.
Keril—A sparry substance found in the vein composed of calcareous spar, fluor, and barytes.
Kibble—A bucket used for drawing up lead ore out of the mine.
Kit—A wood vessel of any size.
Knits—Small particles of lead ore.
Knockings—Lead ore with spar as cut from the vein.
Knockstone—A stone used to break the lead ore on, but sometimes it is a piece of cast iron.
Leap—The vein is said to leap when a substance intersects it, and it is found again a few feet from the perpendicular.
Leadings—Small sparry veins in the rock.
Level—An adit, gallery, or sough; generally, the main water-course in a mine.
Lid—See Cap.
Limp—An iron plate used to strike the refuse from the sieve in washing lead ore.
Loading pick—A pick made purposely to cleave or rive up coals and prepare them for laying on the corves.
Loch—A cavity in a vein.
Lot—A certain proportion taken as dues for the lord of the manor, or owner of the mine.
Maul—A large hammer.
Maundrill—A pick for various purposes, but generally used to undermine.
Mear—Thirty-two yards of ground on the vein.
Needle, or pricker—A thin rod of iron put in shot holes, while they are rammed up, and which being then drawn out leaves a hole into which the match is introduced for setting fire to the charge.
Noger—A jumper or borer; a drill.
Nogs—Square pieces of wood which are piled on each other to support the roof of a coal mine.
Noper—See Loading pick.
Old man—Places worked centuries ago, or in former ages.
O'erlayer—A piece of wood on which the sieve is placed after washing the ore in a vat.
Opens—Large caverns.
Open cast—When a vein is worked open from the *day* or surface.
Ore—The mineral as produced in a mine.
Pack—A quantity of materials, either wood or coals, &c., piled up to support the roof, or for other purposes.
Pee—A piece of lead ore.

Pillar—A support for the roof, of timber, stone, or other material.
Pipe—A vein running unlike a rake, having a rock roof and sole.
Plumb—A line and lead to measure with.
Poling—A plank or piece of wood to prevent earth or stone from falling.
Possession—When stowces or wooden frames are placed on a vein it is said to be in possession.
Post—A pillar of coal or other strata left.
Pricker—A thin piece of iron used to make a hole for the fuze or match to fire a blast.
Pringap—A variable distance between two possessions.
Punch—A piece of timber used as a support for the roof.
Rake—An oblique vein.
Ratchell—Loose stones.
Rib—A pillar of coal left as a support for the roof.
Ricket—See Fang.
Rider—A rocky substance which divides the vein.
Ringer—A crowbar.
Rising—A man working above his head in the roof is said to be rising.
Roof—The part above the miner's head; that part of the strata lying immediately upon the coal.
Rubble—See Ratchell.
Run—When the earth falls and fills up the shafts or works, it is said to run.
Safety fuse—An excellent invention, by Messrs. Bickford, Smith, & Davy, of Camborne, for the safe and certain blasting of rocks in mines and quarries.
Scaffold—In a mine a platform made, where some miners work above the heads of others.
Scouring bit—A bit attached to the end of boring rods for the purpose of extracting the rubbish.
Scraper—An instrument to extract the pulverised rock, &c., from shot holes when boring.
Scrin—A small vein.
Seat or sole—The floor or bottom of the mine.
Shaft—A pit, the perpendicular entrance to the mine.
Shakes—Fissures in the earth.
Shift—The time a miner works for one day.
Shot—Blasting.
Sinking—Working deeper or downwards.
Skep or skip—A square box (usually wrought iron) in which the coals are sent up to the pit's mouth.
Sled—A sledge to draw ore without wheels.
Slipes—Flat pieces of iron for the corves to slide on.
Slit—A communication between two adits.
Smelting—Reducing the ore to metal.
Smitham—Small lead ore dust.
Smut—Decomposed dark earthy substance, or coal decomposed by the air at the surface of the earth.
Sole—The seat or bottom of the mine, applied to horizontal veins or beds.
Sole tree—A piece of wood belonging to stowces to draw ore up from the mine.
Sough—An adit or level for carrying off the water.
Spanner—An instrument to turn screws with.
Spindle—A part of the drawing stowces.
Stays—Pieces of wood to secure the pumps in the engine-shaft.
Stemmer—A piece of iron with which clay is rammed into the shot holes to make them water tight.
Stemples—Wood placed to go up and down the mine instead of steps.
Stickings—Narrow veins of ore.
Stope—A piece of mineral ground to be worked.
Stoping—Cutting mineral ground with a pick; working downwards.
Stopping—A dam of bricks or clay to turn the course of the air.
Stowce—Drawing stowce; a small windlass.
Strings—Small veins of ore.
Stowces—Pieces of wood of particular forms and constructions placed together, by which the possession of mines is marked; a pair of stowces possess a mear of ground.
Sump—A shaft under ground, a well or lodge for water.
Swallows—Caverns or openings where the water loses itself.
Tacklers—Small chains to put round the loaded corves.

Thurl—A long adit in a coal pit.
Thurst—The ruin of the incumbent strata after the pillars and stalls are wrought out.
Trogues—Wooden drains like troughs.
Troubles—Faults or interruptions in the stratum.
Trunks—Wooden spouts to convey wind or water; small boxes in which rubbish or dirt is sent up out of the mine.
Tub—A cast-iron cylinder put in the shaft instead of bricking, for the purpose of beating out the water and making it rise to a level.
Tugs—Hoops of iron fastened on the corves to which the tacklers are affixed.
Turntree—A part of the drawing stowces or windlass.
Underlay—When a vein hides or inclines from a perpendicular line, it is said to underlay.
Vein—Any substance different from the rock; a rake vein is oblique; a pipe vein nearly horizontal.
Vat—A wooden tub used to wash ore and mineral substances in.
Wash hole—Where the refuse is thrown.
Walling—When the roads in the mine are made with stone it is called walling. The side of the mine or gangart is frequently called the wall.
Wastes—Vacant places left in the gobbing, on each side of which the rubbish is packed up for the better support of the roof.
Water holes—Places where the water stands.
Weigh board—Clay intersecting the vein.
Wedge—An iron tool to get ore, split rocks, &c.
Whim—An engine or machine to draw ore, &c., worked by horses.
Wind way—A passage left purposely for air.
Wind bore—The bottom pipe in a lift of pumps.
Wind holes—Shafts or sumps sunk to convey wind or air.
Windlass—A machine used to draw up ore, &c.—See Stowces, by which name it is commonly called.
Windless—A place in a mine where the air is bad or short, is said to be windless or airless.
Yokings—Pieces of wood ascertaining possession; stowces.

SPANISH MINING TERMS.

Abra—A fissure, a considerable opening or cavity in the mountain, rock, or lode.
Abronzado—Yellow copper ore, sulphuret of copper.
Acarreadores—Wood carriers.
Acero—Steel.
Achicar—To decrease, to diminish; applied to the diminution of water in any of the workings, lowering the water in the shafts, &c.
Achicadores—Workmen employed in removing the water in *botas*.
Acuña—Die for coining.
Acuñacion—Coining.
Acuñador—One who coins.
Acuñar—To coin.
Ademador—A mining carpenter; a timber man.
Ademar—To timber.
Ademe—Timber work for supporting and securing the works of the mine.
Adobes—Unburnt bricks made of straw, earth, and dung, dried in the sun.
Administrador—Superintendent.
Administracion—Administration, management.
Afinacion—Refining.
Agata—Agate.
Aguafuerte—Aquafortis, nitrous, or nitric acid.
Ahondar—To sink, to deepen.
Ahonde—Sinking or driving downwards.
Alabastro—Alabaster.
Albañil—Mason, bricklayer.
Albaradon—A dyke.
Albayalde—White lead.
Albergue—A natural hollow, a den.
Alcohol—Galena, sulphuret of lead.
Alcribis o Tovera—The tuyere of a smelting furnace.
Alear—To alloy metals.
Aleacion—The art of alloying metals.
Alhondiga—Corn market or public granary.

Alimentos—In mining, an allowance to mine owners, as subsistence, until their mines become profitable.
Almacen—A store-house, store-room, ware-house.
Almadeneta—A stamp head.
Almagra—Ruddle, red ochre.
Almud—12th part of a fanega.
Alquifol—Galena.
Alquilar—To hire.
Alto—The upper part.
Alumbre—Alum.
Ambar—Amber.
Amatista—Amethyst.
Amianto—Amianthus.
Amoldar—To mould.
Amonedar—To coin.
Amparo—The maintenance of the legal right of ownership by continued possession. In mining, this can only be preserved by keeping a certain number of men at work at certain periods, as determined by the mining code.
Anchura—Width, roominess.
Angulo—An angle, a corner.
Antimonio—Antimony.
Aparejo—A tackle, a block and fall, an apparatus, a set of harness for beasts of burden or draft; a pack saddle.
Apartado—Establishment for parting silver and gold.
Aperos—Utensils; also materials, such as gun powder and paper for blasting, &c.
A pique—*Trabajar a pique.* Digging downwards in a vertical direction.
Apolvillados—Rich ores.
Apuradores—Men who rewash the earth from the tinas.
Arcilla—Clay.
Arena—Sand.
Arenilla—Fine sand.
Arrastrar—Applied to where veins unite and form one; to drag.
Arrastre—Mill for grinding ores, employed in the process of amalgamation of silver ores and of gold.
Arreador—Horse driver for malacates.
Arroba—25 lbs. Spanish weight.
Arriero—A muleteer.
Arsenico—Arsenic.
Asbesto—Asbestus.
Aserrador—A sawyer.
Aserrar—To saw.
Asfalto—Asphaltum.
Astillero—Open forest, pasture for mules, &c.
Atacadera—A rammer.
Atacador—Rod for ramming in the charges for blasting.
Atajador—A boy who attends the horses and mules.
Atajo abierto—Applied to a mine when worked in the manner of a quarry, or by an open cut in a rock or mountain.
Atargea—Water-course of masonry.
Atecas—Laborers who collect the water in buckets from the planes of the mines, in order to pass it off by the shafts; also, men who fill the skins in the shafts with water, mud, &c.
Atierres—Attle, rubbish; in the mine, earth preventing the continuation of the work.
Atisador—A stoker, man who attends the furnace.
Audiencia—Principal tribunal of justice.
Aviado—The mine owner supplied with funds for working his mines.
Aviador—He who supplies funds for working mines.
Avio—Funds advanced for working mines.
Avios—Implements.
Ayudante—Assistant.
Azabache—Jet.
Azanca—A leat.
Azarcon—Red lead.
Azogue—Quicksilver; silver ore adapted for amalgamation.
Azogue apolvillado—Very good ore for ditto.
Azogue commune—Common ore for ditto.

Azogue ordinario—Ordinary ore for amalgamation.
Azogue razonable—Middling ore for ditto.
Azogue en caldo—Quicksilver.
Azogueria—The ware-room, in which quicksilver is kept in store.
Azoguero—An amalgamator; person who superintends the process of amalgamation.
Azufre—Sulphur.
Azufre viro—Native sulphur.
Bancos—Rocks, which intercept the vein, or cause it to take a different direction.
Banquillos—Stools on which the marquetas are placed.
Baño—The last portion of quicksilver applied to a torta.
Barquina—A large furnace.
Barquines—Forge bellows.
Barra—A bar, an iron crow; equal shares into which the interest in a mine is divided, usually 24 in number.
Barra de plata—A bar of silver, usually about 135 marcs, or 1,080 ounces.
Barranca—A ravine.
Barrena—A drill or borer used in blasting.
Barrenadores—Miners who work with the borer and mallet.
Barrenar—To bore.
Barrenero—A boy who attends with the boring tools.
Barrenos—Holes made for blasting.
Barreta—A miner's bar or crow.
Barreteros—Miners who work with crow bars, wedges, or picks.
Barro—Clay, loam, mud.
Basalto—Basalt.
Batea or *Apuradera*—A bowl used in re-washing.
Baxo—Beneath, low, lower part.
Beneficiar—To extract the metal from the ore; to dress ore.
Beneficio—Making the metallic contents of the ore available by reduction.
Beneficio de cazo—Reduction of ore by amalgamation, conducted in a copper pan over a fire; hot amalgamation.
Beneficio de hierro—Reduction of ore by amalgamation, with the addition of fragments of iron.
Beneficio de patio—Reduction of ore by amalgamation, in sheds or open courtyards.
Beneficio de pella de plata—Applied when a portion of amalgam of silver is added to the mass under amalgamation.
Beneficio de la colpa—A method of amalgamation, in which, instead of *magistral*, *colpa* (colcothar) is used.
Beneficio por fuego—Reduction of ore by smelting.
Berilo—Beryl.
Bigorneta—A small anvil.
Bigornia—An anvil.
Bismut—Bismuth.
Blandura—Soft, crumbly ground.
Blenda—Blende, sulphuret of zinc.
Boca—Mouth, entrance, or pit of a mine; first opening made in the vein.
Boca mejora—A shaft or boca to communicate with the entrance of the vein to facilitate the workings.
Bochorno—Vapor, or foul air; want of ventilation; suffocating heat.
Boletas—Tickets of sale of ores; cheque tickets; account of charges, and produce of one amalgamation operation.
Bolsa—A purse; sometimes applied to a bunch of good ore of the supposed shape of a full purse or bag.
Bomba—A pump.
Bonanza—Prosperity; fine weather. A mine in *bonanza* is in a prosperous state; stopping costs, yielding profit.
Bordes—Border; ore left untouched by previous working in an old mine work.
Bordeta—A small pillar.
Borrasca—Adversity; foul weather. A mine in *borrasca* is in an unproductive state; does not stop costs.
Bota—A leather bag or sack, made of one or more ox skins, in which water is lifted in the mines.
Bota chica—Small leather bag.
Bota grande—Sack made of 2 or 2½ hides, used to extract water, and worked by horse whims.

Botilla de burro—Sack, or bag, made of one neat hide, to extract water, and worked by a burro or hand whim.
Botilla de lomo—Small sack made of one-third of a hide, to carry water out of small sinkings on men's backs.
Boveda—Vault, arch.
Braceage—Brassage in coining.
Broculas—Drills.
Bronce—Brass; gun metal; iron pyrites.
Buytron—Furnace for smelting ores.
Burilada—A chip taken from a mass of silver to try whether it be standard.
Burro—A hand whim; a windlass.
Busca—(Search) The right to employ *buscones* frequently claimed by the administration and persons employed in mines.
Buscones—Tributors or miners who work on part proceeds; also, those who search for ores in a metalliferous district generally, or in a mine for such ores as may have been neglected, and left behind by others.
Caballerangos—Horsekeepers.
Caballitos—Men who carry the mining captains or others.
Caballo—A horse; a mass of the steril mountain rock immersed in the lode.
Caballo de tepatate—A mass of barren rock interposed in a vein.
Cadena—A chain.
Cajon—In Peru and Chili two montons of 32 quintals each, 64 quintals.
Cajon de granza—The pit to receive the crushed ore.
Cajonero—A lander, or one who receives the bota or manta at the shaft's mouth.
Cal—Lime.
Calde estaño—Calx of tin.
Calderas—Boilers.
Calentadura—The first heating of the furnace, or putting the furnace into blast.
Caliche—Calcareous matters; ores of a calcareous character.
Calicheros—Lime burners.
Calientes—Warm ores (in amalgamation) containing sulphuret of iron and copper, and no calcareous matter.
Caliza or Cal en piedra—Limestone.
Cal viva—Quicklime.
Campistas—Tributors.
Campo—A pitch, a working in possession of buscones, or allotted to the proprietors or others.
Canal—A spout, a canal.
Candallero—A socket deeper than the chumacera, and used for the same purpose.
Canella—Used to convey the fire to the charge for blasting.
Cañon—In a mine, a level, or horizontal gallery.
Caños—Pipes, tubes.
Cantera—A quarry.
Cantero—Stone mason; quarryman; a pitcher.
Caparossa—The person in charge of the sheds under which the tahonas are worked.
Capellinas—Large iron or copper bells, under which the quicksilver is separated from the silver in the amalgam by distillation.
Carbon—Coal; charcoal.
Carbon de leña—Charcoal.
Carbon de piedra or *Carbon de tierra*—Pit coal.
Carboneros—Carriers, makers, and sellers of charcoal.
Carcamo—The drain which carries off the earthy matter from the tinas when washing the amalgam.
Cardenillo—Verdegris.
Carena—An upright stanchion for supporting machinery.
Carga—380 lbs. Spanish; a mule load, varying in the different mining districts; a charge for blasting; a lode.
Carpintero—A carpenter.
Carilleros—Ore carriers.
Carretilla de mano—A wheel barrow.
Carrita—A wagon or cart.
Carritero—A waggoner.
Casa de moneda—The mint.
Cascajal—A gravel pit.
Cascajo—Gravel, rubbish.
Caso—A boiler used in hot amalgamation.

Castillo—The frame of the stamping machine.
Castina—Fluor, or flux.
Cata—A mine of no great depth, a pit made in quest of the vein, a mine denounced for trial.
Catear—To search for new mines.
Catero—A searcher for mines.
Caxa—Money chest, treasury.
Caxa del tiro—Reservoir at the bottom of the shaft, sump of the pit, that part of the pit below the deepest level driven from it.
Caxo—A measure of ore containing many quintals, but varying in bulk at different places; at Potosi, 5,000 lbs.; a hand-barrow.
Caxoneros—Landers at the mouth of a shaft.
Cebar—To feed; to supply a furnace with materials for smelting; to add quicksilver to a mass of ores under amalgamation.
Cebo—Priming, as of gunpowder; a feed, as oats for horses; second addition of quicksilver to the torta.
Cedazos—Sieves.
Cendrada—The bottom of the refining or cupelling furnaces, made of very fine earth and vegetable ashes which have been lixiviated; materials of which a cupelling test is made; the test itself.
Cendradilla ò Galeme—Cupelo.
Cerro—A mountain.
Cestas—Baskets.
Chapas—Iron blocks on which the stamps fall.
Charqueadores—Cart fillers.
Charqueo—Filling the baskets by hand.
Chichicles—Crystallised calcareous or other spar.
Chicuites—Baskets.
Chiflon—Trabajar chiflon. A phrase, meaning the work making way, both in length and depth.
Chino—Iron or copper pyrites.
Chumacera—An iron socket for the sockets of shafts.
Cielo—Roof of a work, an upward working. *Trabajar de cielo*, working at the roof or top of the vein.
Cilindro—A cylinder.
Cinabrio—Cinnabar, sulphuret of mercury.
Claro—An open space on the lode from which ore has been taken.
Clavos—Masses of native metal, bunches or masses of ore; nails.
Cobalto—Cobalt.
Cobre—Copper.
Cobre en roseta—Rose copper.
Cobriso—An inferior kind of copper ore.
Colero—Assistant of the underground captain in charge of the peonada, or account of the daily labor.
Cohete—A cartridge for blasting.
Collado—A hill.
Colorados—Ores colored with red oxide of iron.—(See *Pacos.*)
Comillo—A reverberatory furnace.
Comer los pilares—To take away the pillars of the lode which had been left during the previous working of the mine to support the roof, and consequently to abandon the mine.
Comerse los pilares—The same as *comer los pilares*, figuratively to abandon a mine.
Compromiso—A private engagement or undertaking; also a joint stock undertaking.
Conducta—A convoy or caravan, conveying the precious metals or coin over land.
Contra cielo—A rise or working upwards.
Contra mina—A work of communication between two mines; also an adit.
Convenio—A legal agreement.
Contra tiro—Auxiliary pit contiguous to a main pit or shaft, to serve as a footway, or for ventilation.
Copola—A cupelling furnace.
Copos or *Paxillas*—In amalgamation, little globules into which the quicksilver forms, when the process is too quick.
Coral—Copper.
Cortar pilar—To complete the pillar, and make a cross passage, and to form a landing-place.

Cortar las sogas—To abandon a mine; *lit.* to cut the ropes.
Costadores—Wood cutters.
Costal—Sack for ore, made of the *pita* or thread of the aloe; a rammer or beetle.
Cras—An iron cage or frame used in smelting.
Creston—Out-cropping of a lode; the crest of a lode appearing above the surface of the ground.
Criadero—A spot which is metalliferous; a spot, a district, a mountain, a rock where ores are supposed to grow.
Criba—Perforated leather, through which the stamped ore falls into a pit.
Crisolito—Chrysolite.
Cristal—Crystal.
Cristal de roca—Rock crystal.
Crucero—A cross cut.
Cruces—The cross pieces of the arrastres or grinding mills.
Cruzada—Applied to lodes, that which is crossed by another.
Cubo—A leather or other bucket.
Cuchara—The scraper used for extracting the pulverised ore or rock in the hole made to receive the charge for blasting; a spoon.
Cuchara de cuerno—A small horn bowl in which the earth of the tortas is washed, in order to ascertain from time to time the progress of the amalgamation.
Cuele—The art or effect of cutting or driving a mine; work in any direction; the distance or space advanced in a mining work.
Cuerda—A rope.
Cueros—Skins, generally of oxen, cows, &c.
Cuña—A wedge.
Curtir—The operation of adding lime to warm ores, or magistral to cold ores in amalgamation.
Cuerpo—The lode; also, body, as *cuerpo de la veta*, body, or main vein of the lode.
Cuerpo alto—Upper branch of the lode; upper story of a house or store.
Cuerpo baxo—Lower branch of ditto; ground floor of ditto.
Cuerpo medio—Middle branch of ditto.
These three terms are used where a lode is divided into three parallel branches with the same underlay, as at Veta Grande, Guanaxuato.
Dedo—The 12th part of a palmo; 4 palmos making 1 vara—12 dedos—8 pulgadas, or Spanish inches.
Demasia—Space unappropriated between mines, or otherwise.
Denuncio—Denunciacion—Denouncement; a formal application to the court of mines of the district, to have a mine adjudged to the applicant, the workings of which have been abandoned, or inefficiently carried on during the period fixed by the ordinance, or which has never been worked at all. A person has the power of denouncing a mine which has been unworked, or inefficiently worked, or depopulated for more than four months.
Deputacion de mineria—Mining tribunal.
Derecho—Straight, right.
Derrumbe or *Derrumbamiento*—The falling in of the works of a mine.
Desaguador—Water pipe or conduit.
Desagüe—Drainage.
Desagües—Outlets of every description by which the water is got rid of.
Descargue—Drawing off the last contents of the furnace, blowing out the furnace.
Descostradores—Men employed in taking down any fragment which may remain after blasting.
Descubridora (mina)—The mine in which the vein has been discovered, and which is entitled by law to a double *pertenencia* if in a district already worked, or a treble *pertenencia* if in a new district.
Desfrutar—To enjoy, to have the benefit of a mine.
Desmonte—Clearing away the surface of the ground; removing by the pick, blasting, or otherwise, the mountain rock, or breaking down ores.
Despacho—Plat; point of junction between a shaft and a level enlarged for receiving the ores, &c., to be sent up the shaft to the surface.
Despachadores—Men employed in filling the *mantas* with ores, &c.
Despensa—A store room for materials and tools, sometimes also for the quicksilver, and even for the bullion.
Despueble—Abandoning the mine, or omitting to keep the proper number of hands at work.
Destajo—Piece or contract work; tut work.
Destajero—Tut workman, or one who undertakes to work by contract.
Diamante—Diamond.

Dique—A dike.
Echadero—A plain where the mules are loaded, the metal spread out, cleaned, and weighed.
Echado—Inclination, or dip of the slope.
Ege—The axis of a wheel, axis of a carriage, &c.
Embolo—A piston.
Emborrascarse—Applied to a vein which has become barren at the spot then in work.
Emparejar—To level or square; to harness cattle, saddle them.
Empleo—The quantity of quicksilver mixed with the ore on any given occasion for effecting the amalgamation.
En bonanza—Yielding profitable returns.
Encampanar una mina—To cut off the workings of a mine on the underlay by working on the lowest works from the neighboring mine.
Encapillar—To form a chamber, or an enlargement of a working, preparatory to driving another work from it.
En frutos—In produce, producing ores.
Ensalmorar—The first process in amalgamation, the act of mixing the saltierra with the lama.
Ensayador—Assayer.
Ensaye—An assay.
Ensayo—A trial.
Escaleras—Ladders made of poles of timber, with notches cut in them or otherwise.
Esmanil—Blende.
Esmeralda—Emerald.
Esmeril—Emery.
Espato—Spar.
Espato Calizo—Calcareous spar.
Espato fluor—Fluor spar.
Espato pesado—Heavy spar; sulph. of lime.
Espejuelo—Mica.
Espeque—The cross level of the noria or tahona to which the mules are harnessed; a lever.
Estaca fixa—The post driven into the ground, from which the pertenencia is originally measured. *Estaca*, means a stake.
Estado—A statement or account.
Estaño—Tin.
Estanque—Pond, dam of water.
Estoraque—Brown blende, sulphuretted zinc.
Faenas—Work done by common laborers, such as dead work, removing rubbish, &c.
Faenero—Rubbish carrier.
Fanega—A dry measure, containing 12 celamines, or 1,599 of an English bushel.
Fanegada—An extent of land; 90 1-3rd fanegadas are equal to 100 English acres.
Feldespato—Feldspar.
Fierros—Stein, vulgarly regulus, from the smelting furnace.
Flete—Freight.
Fluorspato—Fluorspar.
Fluxo—Flux.
Fondon—A furnace for smelting ores.
Fosforo—Phosphorus.
Fosiles—Fossils.
Fragua—A forge.
Frios—In amalgamation, cold ores, those containing calcareous matter, and therefore requiring a larger quantity of sulphuric acid from the magistral.
Frente—An end; a forehead; an extremity of an adit or other level.
Frijolillo—A breccia.
Frixoles—French beans, the common food of the country.
Frutos—Produce, ore.
Fuelles—Bellows.
Fundidor—A founder, a smelter.
Fundicion—Smelting; also, the smelting-house.
Galena—Galena, sulphuret of lead.
Galera—A large shed, a mill-house, or grinding-mill; a large building on the floor of which the treading in of the quicksilver in amalgamation takes place.
Galleria—A gallery; a level.

Gallos—Small particles of silver, which appear in the shape of spherules on the surface of certain ores, after they have been strongly heated; more generally, however, applied to the spirting out of the silver from the assay button on cooling; also fine specimens of native silver, or other rich ores.
Gamela—A large wooden bowl.
Galpeador—A miner, who works with the mallet or hammer in blasting.
Granada—Garnet.
Granito—Granite.
Grano—A grain.
Granos de oro—Grains of gold.
Granza—Coarse particles of ore after grinding which require to be ground again; brayed ore.
Granzas—Poor ores.
Grasas—Slag from the smelting furnace.
Greda—Chalk.
Greña—Ores in the rough state, not cleaned.
Greta—Litharge, fullers' earth.
Gualdra—The large cross-beam in which the upper spindles of the shafts of machinery traverse.
Guarda—A rib of different substance from the rock or lode, which generally is upon the sides of the vein, called in Cornwall, cupels of a lode, or backs.
Guarda raya—Marks or limits of the boring, or measurement of the work done in a mine; limit or boundary line.
Guia—A mark directing to the richest part of the vein.
Guijarro—Pebble.
Guijo—The iron spindle of the shaft of machinery.
Guixa—Quartz.
Hallilitador—He who supplies money for working a mine.
Hachas—Axes, hatchets.
Hacienda—Farm; estate; establishment for reducing ores.
Hacienda de beneficio—Establishment for reducing ores.
Hacienda de fundicion—Establishment for smelting ores.
Haciendero—The superintendent of the hacienda.
Hechado—Dip of the lode.
Herramienta—Tools; taken figuratively, it implies a borer and hammerman.
Hierro—Iron.
Hierro colado—Cast iron.
Hierro labrado—Wrought iron.
Hilo—A small vein or thread of ore in a lode.
Hilo de la veta—Line or direction of the vein.
Hilos altos—Threads or small veins of ore falling into or proceeding from the upper or hanging wall of a lode.
Hilos baxos—Threads or small veins of ore proceeding from or falling into the lower wall of a lode.
Hoja de lata—Tin plate.
Hoja de laton—Sheet brass.
Hoja de libro—Finely laminated clay—slate; talc. *Lit.* leaf of a book.
Horno—A furnace.
Horno de fundicion—A smelting furnace.
Horno de magistral—Roasting stove for copper stove.
Huaco—A hollow.
Hueco—A hollow place.
Huembas—Small rough beams of buildings.
Hundido—Sunk in; workings which have fallen in.
Jantilla—A double-handed ladle into which the melted silver falls from the cras.
Jaspe—Jasper.
Jornaleros—Day laborers.
Jorongo—A small basket; also a blanket.
Incorporar—In amalgamation, to add the first charge of quicksilver. The term, *cebar*, is applied to the adding the subsequent charges; it also means the act of mixing in thoroughly the whole of the quicksilver, with the torta of wet ore.
Ingenios—Engines.
Instrumentos—Instruments, tools.
Intendente—Intendant.
Interventor—Inspector, representing the interests of the proprietors by whom appointed, or of the *aviador*.
Iridio—Iridium.

Labor—A work from which ores are extracted; in general, all work of the mine, and especially the front work.
Labores de hacienda—All workings in a mine not let to tributors.
Ladrillera—An iron or stone mould in which the melted silver is poured in order to form the barra.
Ladrillos—Bricks.
Lama—Slime or schlem from the amalgamation.
Lamero—The lama when merely thickened by admixture with saltierra.
Lameros—Lama pits.
Lancha—A sort of hard freestone.
Lapiz—Black lead.
Lapiz encarnado—Red chalk.
Laton—Brass.
Lava—Lava.
Lavador—A man employed in washing the ore after amalgamation, or rather, in cleansing the amalgam.
Lavaderos—Gold washings; washing vats or tubs for separating the amalgam from the lama or slime.
Lazadores—Men who procure people to work in the mine; also men employed to catch cattle.
Leña—Fire wood.
Leñadores—The workmen employed to carry and serve the wood in the smelting furnace; also, the wood cutter; collectors and sellers of fire-wood.
Lenter nillas—Large vertical wheels of the stamping apparatus.
Ley—Standard of the metals; contents in pure silver.
Ley de oro—Quantity of gold contained in the silver.
Ley de plata—Quantity of silver contained in the ore.
Libramiento—Warrant for payment for bars of gold or silver delivered at the mint, or order for funds.
Libranza—A bill of exchange.
Liga—Flux.
Limadura—An appearance put on by the quicksilver in certain stages of the process of amalgamation, which is noticed at the edges of the amalgam, washed in the bowl for making a *tentadura*, or trial.
Limpia—Clearing out of rubbish and ruins from the old work in a mine.
Lis—A particular state of the amalgam observed by means of the *tentaduras*, or trials, in the bowl.
Llano—A plain, flat ground.
Llevada—Carriage, transport.
Llevador—Carrier, conductor.
Lodo—Mud.
Losa—A flat stone.
Lumbrera—An air shaft; an adit shaft.
Macero—He who has the charge and direction of crushing and grinding the ore in the tahonas, previous to amalgamation.
Macizo—A solid untouched part of the vein.
Madera—Timber.
Maestro herrero—Master blacksmith.
Maestro carpintero—Master carpenter.
Magistral—Copper pyrites, used in amalgamation.
Malacate—A horse whim.
Malacatero—A whim driver.
Malacate doble, or Malacate sencillo—The former whim has bags made of two ox hides, holding 1,250 lbs. of water; the latter one hide, and holding half the quantity.
Maiz—Indian corn, the principal food used at the mines.
Manantial—A spring of water.
Mandadero—Errand boy.
Mandon—Master miner or overseer.
Manga—Level divided for ventilation; air pipes; a bag or strainer used to separate the quicksilver from the *pella*.
Manganesa—Manganese.
Manta—A blanket, or horse cloth, used to contain ores or tools to be brought up by the malacates, now replaced generally by sacks made of the fibres of the agave, or ox hides.
Mantear—To raise ores from the shaft in bags or mantas.
Manto—A bed or circumscribed stratum.

Maquina—A machine.
Maquila—Rate paid to the proprietor of a mill, or reduction work, for reducing ore on another party's account; applied chiefly to reduction by amalgamation.
Maquilero—One who dresses ores on hire.
Maquinas de vapor—Steam engines.
Marco—8 ounces or lb. Spanish, equal to 3,552 grains English.
Marco de oro—8 ounces of gold.
Marco de plata—8 ounces of silver. The marco de oro, or marco de plata may be standard, or otherwise.
Marmol—Marble.
Maroma—A rope to pull or draw by as a hawser.
Marquesitas—Mundic; iron pyrites.
Martillo—A hammer.
Martriquila—A registry for miners, &c.
Maza—Stamp head for pounding the ores.
Mecha—A match or fuze.
Medida—A measure.
Mejora—Improvement.
Mejora de boca—A term used when an improvement or alteration is made in the entrance to a mine.
Memoria—Weekly account of disbursements or mine expenses.
Mercurio—Quicksilver.
Merma—Loss of quicksilver in amalgamation, or of lead in smelting.
Meson—An inn mostly appropriated to muleteers, &c.
Metal—Metal; ore.
Metal de ayuda—Metal or ores added in smelting, to assist in the reduction of the silver ores; lead, or galena, for example.
Metal pepena—Selected and picked gold and silver ores.
Metales communes—Common ores.
Metales de fundicion—Ores for smelting.
Metales plomosos—Ores impregnated with lead.
Metales porosos—Porous ores.
Metapiles—Grindstones used in the tahonas; also pigs of copper used in the hot amalgamation.
Mexquite—Robinia, or acacia; a wood much used in mines.
Mineral—Ore; mineral; recently applied to a mining district, formerly and still called Real de Minas.
Mineria deputacion de—A tribunal cognizant of mining matters, elected in most cases by the mine owners of the district.
Minero—A miner, an underground agent.
Minio—Red lead.
Modelos—Models.
Mojon—A land mark, used to mark the limits of pertenencias.
Molibdena—Molybdena.
Molienda—The act of grinding or pounding the ores, sometimes used to designate the ores ground "*La Molienda.*"
Molinete—Shaft of tina.
Molino or *Mortero*—Stamping mill.
Molonques—Crystalisation of silver ores; very rich.
Montaña—A mountain.
Montes—Woods.
Monton—A heap of ore; a batch under the process of amalgamation, varying in different mining districts. At Catorce, 36 quintals; at Guanaxuato, 35 quintals; at Real del Monte, Pachuca, Sultepec, and Tasco, 30 quintals; Zacatecas and Sombrerete, 20; Fresnillo, 18; Bolanos, 15; and at Valenciana, 32.
Mozo—A man servant.
Muestras—Samples.
Mufla—A tuyere.
Natas o Escorias—Slags.
Natron—Native carbonate of soda.
Negociacion—Business; undertaking as a mine, or set of mines, &c.
Nicolo—Nickel.
Nitro—Nitre.
Nivel—Level.
Niveles de agua—Water levels.
Noria—An endless chain with buckets attached, revolving round a wheel; it is used under-ground for drawing water out of the pozos or sinks, which are car-

ried down to a greater depth than the principal shaft; also, a common superficial machine for raising water.
Obras—Workings.
Ocre—Ochre.
Ocre rojo or *Ocre colorado*—Red ochre.
Official de albañil—Journeyman bricklayer.
Official de carpintero—Journeyman carpenter.
Ojo—Bunch or small spot of ore in a lode.
Ojo de polvilla—Spots of rich ore.
Ojo de vibora—Black sulphuret of zinc.
Onique—Onyx.
Opalo—Opal.
Operanos—Workmen.
Ordenanzas de mineria—Code of mining laws.
Oro—Gold.
Oro de copela—Fine gold.
Oro empolvado—Gold dust.
Orphimento or *Oripomente*—Orpiment.
Pacos—Earthy ores, consisting of oxide of iron mixed with various ores of silver; when of a red color they are frequently called colorados; they are generally found near the surface.
Paja—Straw.
Pala—A wooden shovel.
Paldion—Palladium.
Palanca—A lever, a pole on which a weight is supported by two men.
Palansa de hierro—Crowbar.
Palmo—Quarter of a vara or Spanish yard.
Panino—The ground or country through which the lode runs; also, the matrix.
Panizo—Hornstone.
Parada—A relief or change of men, mules, or horses.
Parcionero—A partner in the mines.
Parihuela—A letter.
Partido—Division of ores between the owners and buscones.
Pasta—Uncoined silver.
Patio—A yard; court; floor of a court on which the ores pass through the process of amalgamation.
Patio de amalgamacion—Amalgamation court.
Pegador—Man who sets fire to the matches for blasting.
Pella—The silver mixed with quicksilver when all the latter metal has been forcibly pressed out, except the portion which can only be separated by distillation.
Peltre—Pewter.
Peones—Native laborers or assistants; day laborers.
Pepena—Picked ore of the best quality; rich ore.
Pepenado—Cleaned ores.
Pepenadores—Cobbers, cleaners, and classers of the ores.
Pepitas—Small grains of native silver or gold.
Peritos—Intelligent or practical persons selected as arbitrators to decide scientific or practical questions or disputes, or to determine the underlay of veins prior to fixing the limits of the *pertenencias*.
Perla margarita—Pearl.
Pertenencia—Extent of 200 varas upon the course of a lode to which a title is acquired by denunciation; the breadth varies according to the underlay of the vein from 112½ varas to 200 varas.
Peso—A dollar; any weight.
Petlanques—Crystalisations of siver ores; also, silver ores which are very conspicuous in the matrix; for example, petlanque colorado is the red antimonial silver, whether crystalised or otherwise.
Pez—Pitch.
Pico—A miner's pick.
Piedra—Stone.
Piedra de toque—Touchstone.
Piedra cornea—Hornstone.
Piedra iman—Loadstone.
Piedra podrida—Rotten stone.
Piedra pomez—Pumice stone.
Piedras de mano—Good pieces of ore, sometimes carried up by hand, and often assigned to pious purposes.

Piedras preciosas—Precious stones.
Pilares or *Pilarejas*—The pillars of a mine.
Pileta—A trough; the hollow basin before the smelting furnace into which the metal flows; tank or small reservoir underground to collect the water of infiltration.
Piña—The cake of silver left after the quicksilver has been distilled off.
Pinta—The appearance, whether favorable or unfavorable, of a fragment detached from the lode; the mark of particular metals by which their value is recognised according to their appearance to the eye.
Pintra—To exhibit pintas, or indications of ores.
Pirites—Sulphuret of iron.
Piso—The bottom or floor of a work.
Pison—A rammer.
Pita—Thread made of the fibre of the agave or maguey.
Pizarra—Slate.
Plan—A bottom working, or working driven from the bottom of a level, adit, &c.
Plancha—Pigs, as *plancha de plomo*, pigs of lead.
Plata—Silver.
Plata de ley—Standard silver.
Plata parda azule y verde—Muriate of silver of different colors.
Plata piña—Silver after distilling off the mercury.
Platina—Platinum.
Pleito—A law suit.
Plomo—Lead.
Plomosos—Applied to ores containing lead.
Poblar—To set on workmen in any mine.
Polvillones—Rich ores.
Polvillos—Applied to ores, tender, rich.
Polvillos buenos—Good ores of the kind.
Polvo—Dust.
Polvora—Gunpowder.
Polvorilla—Black silver, disseminated sulphuret of silver.
Porfido—Porphyry.
Potaza—Potash.
Pozo—A sink on the inclination of the vein; a pit, a well.
Presa—A dam.
Protocolo—Minutes.
Pueble—Actual labor in the mine with the number of workmen at least prescribed by the mining laws.
Puertas—Very strong rock which conceals the vein, and which requires blasting ere the vein is discovered; also doors.
Pulgada—An inch.
Quadrado—A square.
Quajado—Dull lead ore.
Quarzo—Quartz.
Quebrada—A ravine.
Quebradores—Cobbers or breakers of the ores; men who break up the ores on the surface.
Quemadero—Burning house or place.
Quemazon—The barren scorched appearance of the crest of a metalliferous lode protruding from the surface of the mountain.
Quilate—Synonymous with carat; for example, gold of 22 quilates contains 22-24th parts of pure gold, just as the English standard gold of 22-24th parts of pure gold. The quilate is divided into 4 granos Spanish.
Quintal—4 arrobas or 100 lbs. Spanish, equal to 101 45-100 lbs. English.
Quita pepena—A man who stands at the mouth of the shaft to see that none of the metal is stolen.
Ramo—A branch from the main vein.
Rancho—A detached farm-house and ground; the house is often nothing more than a hut.
Raya—Weekly account of the mine expenses.
Rayador—Clerk who keeps account of the workmen's time, the stores received, &c., &c.
Real—1-8th of a dollar; a mining district.
Real de minas—The term generally applied to a mining district; although Mineral de Minas is also now used.
Reata—A rope about as thick as a finger, or larger, used as lashings to *cargas*.

Reatilla—A single twisted smaller rope.
Rebaxe—A working down of high ground.
Reboltura—A mixture of the ground ore with the usual re-agents or fluxes.
Rebosadero—Crest of a vein.
Recina—Rosin.
Recuesto—Inclination of a vein.
Regador—One who has a right to a certain share of water for irrigation.
Registrar—To get an entry made by the proper officer of a party taking possession of a new mine.
Registro—An entry as above described.
Reliz—The wall of the vein.
Remolino—Mass or bunch of ore.
Rendirse—In amalgamation, said of a torta when the amalgamation is complete.
Repasador—Laborer who treads the quicksilver into the ores under amalgamation.
Repasar—The mixing together of the ore, quicksilver, and other ingredients in the wet state, in order to extract the metal; to work the quicksilver into the tortas of ore under amalgation, done by treading them with mules or men.
Rescatador—Ore purchaser.
Rescate—Public sale of ores.
Retortas—Retorts.
Rio—A river.
Riscos—Crystals.
Rosicler—Ruby silver; red antimonial ore.
Rubi—Ruby.
Ruedas—Wheels.
Rumbo—Point of the magnetic compass.
Rumbo de la veta—Line or direction of the vein.
Saca—The ore obtained from a mine in a given space of time.
Sacabocados—Punches.
Sacabuches—Hand pumps.
Sal—Salt.
Sala—The principal room of a hacienda, or any other building.
Salitre—Saltpetre.
Sal mineral—Mineral salt for amalgamation.
Sal tierra—Impure or earthy salt.
Salineros—Applied to ores requiring much salt in amalgamation.
Salones—Saloons, large halls, hollows, or cavities in a lode.
Sangria—Letting off water by piercing the rock or other substance which dammed it in.
Sanguinaria—Blood stone.
Scrape—Blanket, the usual dress of miners.
Sebo—Tallow or suet used for machinery, &c.
Sierras—Saws; chain of mountains.
Silla—A saddle; a leather which passes over the men's shoulders to protect them in carrying the ore.
Sitio de labor—Land measure, 5,000 varas in diameter.
Sobrante—Surplus, profit, residue.
Socabon—An adit or water level driven from the earth's surface, either on the course of a lode, or to intersect it.
Soga—The rope to which the bota is attached.
Soguilla—The rope for the botillas de burro, botas chicas, or mantas.
Soldadura—Solder.
Soliman—Corrosive sublimate.
Sombra—Shade; grey tinge of certain ores or matrices of ores.
Soto minero—Sub-miner.
Soplete—A blow-pipe.
Sucino—Amber.
Tablas—Planks.
Tahona—A mill of small horizontal stones.
Tajadera—Wedge to break the tinas.
Tajo—A cut.
Tajo abierto—An open cut.
Talco—Talc.
Talega—Bags of dollars, containing 1,000.
Tanda—Task; compulsory labor; days appointed for working the mine; duration of the period in which a regador is entitled to use running water for irrigation.
Tanque—Tank or artificial pond.

Tantalio—Tantalum.
Tapa ojos—Bandage for the eyes; used to cover the eyes of mules when treading the ore in the patio, or elsewhere.
Tarea—A task; also a certain quantity of wood for fuel; the quantity cut upon one task.
Tejamanil—Shingle for roofing.
Tejo—Cake of metal.
Telluric—Tellurium.
Tenatero—Ore carrier from the workings to the surface, or to the despacho only.
Tenates—Sacks made of pita, or hide, for raising the ore on men's shoulders; large leather or coarse linen bags, in which the tenateros remove the ores and rubbish.
Tentadura—An assay or trial.
Tepetate—Rubbish remaining after cleaning the ores; also applied to all the earth of the mine which contains no metal; barren rock through which the ore runs.
Terquesite—Native carbonate of soda.
Terreros—Heaps of attle and rubbish from the mine.
Tersoreria—Treasury.
Testera—A dyke interrupting the course of a lode.
Texear bien en horno—When the litharge is thrown out from the furnace.
Tienda de raya—A shop at which the miners obtain weekly credit.
Tierra pesada—Barytes.
Tierras—Earths, applied to ores, earthy, poor.
Tierras apolvillados—Ores a degree inferior to azogues apolvillados.
Tierras communes—Common earthy ores.
Tierras de morlero—Poor stamped ores.
Tina—A vat or jar.
Tiro—A shaft.
Tiro de mulas—A set of mules.
Tiro general—The principal shaft.
Titanio—Titanium.
Tornero—A wooden vat.
Torta—A certain quantity of ore under amalgamation forming one heap, which being of a flat shape is called a torta or cake.
Torta rendida—Amalgam ready to undergo the washing operation.
Trementina—Turpentine.
Triangulos—The cogs of the stamps.
Tribunal de mineria—Mining tribunal.
Trompeto—A small malacate.
Tungstena—Tungsten.
Turba—Turf, peat.
Turbit mineral—Yellow oxide, or sulphuret of mercury.
Uranio—Uranium.
Vapor—Steam; foul air in a mine.
Vara—A Spanish yard, equal to 33 inches English nearly; 109 30-100th varas, equal to 100 English yards.
Velador—A watchman who takes care of the mine day and night; an under miner.
Velas—Candles.
Vena or Veta—A vein or lode; it is called *manta* (a cloak) when it is a bed; *clavada* (upright) when it is vertical or nearly so; *echada* (inclined) when it has a certain dip or inclination; *obliqua* (oblique) when it goes in that direction through the mountain; *serpenteada*, when in a serpentine direction; *socia* (companion) when it is joined with another; *rama* (branch) when it proceeds from the main vein.
Verde tierra—Verditer.
Vermellon—Vermilion.
Veta madre—The mother or principal vein.
Vidrio—Glass.
Vigas—Beams, split or sawed timber.
Vitriolo—Vitriol.
Vitriolo azul—Blue vitriol.
Vitriolo blanco—White vitriol.
Vitriolo verde—Green vitriol or copperas.
Voladoras—Grinding stones of the arrastres.
Vuelta—The glow of the silver in cupellation when the last film of oxide of lead suddenly separates and disappears.
Xabon—Soap; a peculiar description of ores.

Xabones buenos—Good ores of the above description.
Xacal—A hut in which ores and tools are kept.
Yesca—Vinder or touchwood.
Yeso—Sulphuret of lime.
Yunque—Anvil.
Zacate—Maize straw or grass given to the mules.
Zanca—A ditch.
Zurron—A sack made of leather; Cochineal is packed in zurrones.

FRENCH, SPANISH, AND GERMAN SMELTING TERMS.

CONTRACTIONS.—Fr. *French;* Sp. *Spanish;* Gm. *German.*
Cp. Copper; *Sl.* Silver; *Ld.* Lead; *Tn.* Tin; *Ir.* Iron.

Abstrich—Gm. sl.; impure brown litharge, in silver refining.
Abzug—Gm. sl.; sulphurated litharge dross, in silver refining.
Affinerie—Fr.; refining metals.
Arastre—Sp. sl.; crushing mill.
Aspirateur (*fourneau*)—Fr.; air or wind furnace.
Autel—Fr.; the fire bridge of the air furnace.
Battitures—Fr.; forge scales of oxide of iron.
Bleistein—Gm. ld.; regule from coppery (&c.) lead ores.
Blicksilber—Gm. sl.; crude silver, from silvery lead, not quite fine.
Brandsilber—Gm. sl.; refined silver, from silvery lead.
Brasque—Fr.; lining of close beaten charcoal.
Cadmies—Fr.; metallic soot; sublimate.
Capelline—Sp. sl.; the iron bell under which the silver amalgam is distilled downward.—See Pina.
Carcasses—Fr. sl.; coppery residues of liquiation for silver.
Castine—Fr. ir.; limestone.
Centner—Gm.; proportionate weight of 100; whether pounds, ounces, loths, or grains.—See Loth.
Chemise—Fr.; lining of a furnace.
Cingler, Cinglage—Fr. ir.; shingling.
Crasses—Fr.; clots, dross.
Creuset—Fr.; crucible; receiving pit of a furnace.
Cuivre Ampoulé—Fr. cp.; crude copper ready for refining called "pimple copper."
Cuivre en Grains—Fr. cp.; beanshot copper.
Cuivre en Plumes—Fr. cp.; feathershot copper.
Cuivre Noir—Fr. cp.; coarse copper for refining.
Dame—Fr. ir.; the front hearth stopper of the high blast furnace.
Darrlinge—Gm. sl.; copper residue from silvery copper, sweated out by lead.
Decrassage—Fr.; skimming, cleaning.
Dunnstein—Gm. cp.; poor copper regule.
Eclair—Fr.; the "brightening" of fine silver in cupellation.
Erzmehle—Gm.; ground ore.
Etain en larmes—Fr.; grain tin.
Fallung—Gm.; precipitation in watery solution.
Floss-ofen—Gm. ir.; the high blast furnace.
Fonte—Fr.; cast metal; generally cast iron.
Fonte crue—Fr.; fusion of regule from raw ore.
Fourneau a manche—Fr.; low blast furnace.
Foyer—Fr.; fire-hearth of a furnace; focus.
Fraisil—Fr.; broken small charcoal.
Frischstuck—Gm. sl.; silvery lead eliquiated from silvery copper ore.
Gahreisen—Gm.; the iron rod for drawing the sample.
Gahrkupfer—Gm.; refined copper.
Gahrost—Gm.; the copper after the last roasting.
Gahrproof—Gm.; refining test.
Gahrschlag—Gm.; refinery slag.
Gahrspan—Gm.; the refining assay sample.
Gift mehl—Gm.; arsenic soot.
Heller—Gm.; a weight, ½ pfennige; about 7 grs. impl.—See Pfennige.
Houille Grasse—Fr.; bituminous coal.
Houille Seche—Fr.; coal little or not bituminous.
Hutte—Gm.; foundery; kiln; smelting furnace.
Huttenwerke—Gm.; smelting-house.
Kornig—Gm.; grainy, as *grob-kornig*, coarse-grained.

Krummofen—Gm.; low blast furnace.
Kupferleg—Gm.; regule from bleistein, roasted with quartzy copper ores, &c.—See Bleistein.
Kupferstein—Gm.; regule from coppery lead ores, twice roasted.
Laitiers—Fr.; fusible slags.
Lama—Sp. sl.; fine ground ore, ore mud.
Lingotiere—Fr.; ingot mould.
Loth—Gm.; a standard weight about ½ ounce impl.
Loupe—Fr. ir.; the ball or bloom from the puddling furnace.
Magistral—Sp. sl.; roasted copper ore, for mixing in the amalgam heap.
Matte—Fr.; regule, melted sulphuret.
Mineral—Fr.; ore.
Monteros—Sp. sl.; stampers.
Monton—Sp. sl.; small heaps of ore mud, for amalgamation.
Niederschlag—Gm.; precipitate.
Noyer—Fr. sl.; the assay being covered with unabsorbed litharge.
Offenbruch—Gm.; metallic soot or sublimate.
Paillasse—Fr.; the bed of a furnace.
Patio—Sp. sl.; amalgamation floor.
Pfennige—Gm.; a weight, 1-16th loth.—See Loth.
Pina—Sp. sl.; piles of amalgam for distilling down the mercury.
Plata Pina—Sp. sl.; the porous silver cakes left after distilling down the mercury.
Plomb d' Œuvre—Fr. sl.; silvery lead for refining.
Pocherz—Gm.; poor ore.
Poussee—Fr. sl.; fusion with nitre, to scorify the copper, &c., and leave the silver.
Quintal Metrique—Fr.; 100 kilogrammes, nearly 217 imperial pounds.
Quintlein—Gm.; a weigh ¼ loth, or 1-16th ounce.—See Loth.
Rable—Fr.; rabble; a toothless iron rake, for skimming, &c.
Raffinage—Fr.; refining.
Rafraichissage—Fr. sl.; melting the silvery copper, &c., with lead, to extract the silver.
Refractaire—Fr.; fireproof.
Ressuage—Fr. sl.; sweating out the lead for eliquiating the silver from silvery copper, &c.
Reverbere—Fr.; reverberatory (furnace.)
Ringard—Fr.; iron rake for stirring melted metal.
Rocher—Fr. sl.; the "branching" thrown out by fine silver in cooling.
Rohstein—Gm.; copper regule, first fusion.
Rondelle—Fr.; the round cake of rosette copper.
Rosette—Fr. cp.; refined copper, coated with bright red oxide, by plunging hot into water.
Rosten—Gm.; roasting.
Rost-stadeln—Gm.; enclosed roasting, sometimes called "case roasting."
Rotissage—Fr.; roasting.
Rustine—Fr. ir.; backstone of the high furnace hearth.
Saigerdorn—Gm. sl.; the coppery residue from darrlinge, (which see,) after sweating out most of the lead.
Saigergasse—Gm. sl.; eliquiation gutter, to draw off the eliquiating lead from silvery copper, &c.
Saltierra—Sp. sl.; salt earth (containing 12 or 13 per cent. salt) for mixing in the amalgamation heap.—See Torta.
Saumons—Fr.; blocks of metal, especially tin.
Schachtofen—Gm. ir.; high blast furnace.
Schlacke—Gm.; slag, scoria.
Schlackstein—Gm. cp.; very poor regule, chiefly iron and sulphur.
Schlamm—Gm.; fine ground ore.
Schlich—Gm.; fine ground ore; ore mud.
Scories—Fr.; metallic slags.
Seigerung—Gm.; eliquiation.
Spadele—Fr.; shovel for turning the roasted ore.
Speise—Gm.; metallic sediment from cobalt glass, contains nickel.
Speissig—Gm.; fibrous, as *klar speissig*, fine fibrous.
Spleiss-ofen—Gm. cp.; split furnace; refining furnace with two receivers.
Spurrost—Gm. cp.; regule after three roastings.
Spurrstein—Gm.; the spurrost melted.
Stahlstein—Gm.; crude steel from the ore.
Stofferz—Gm.; pure ore.